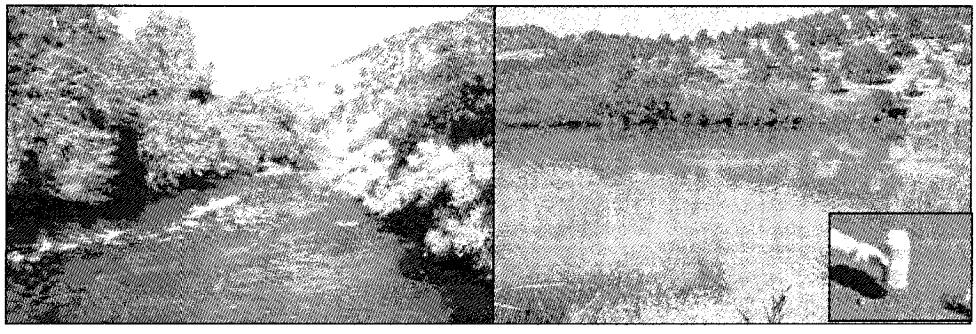
Aquatic Ecosystem Sciences LLC

TECHNICAL MEMORANDUM

Microcystis aeruginosa Occurrence in the Klamath River System of Southern Oregon and Northern California



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INTRODUCTION

Toxic blooms of the cyanobacteria *Microcystis aeruginosa* (MSAE) were documented in Copco and Irongate Reservoirs (the lowermost projects of PacifiCorp's Klamath Hydropower Project--KHP) in 2004 and 2005 (Kann 2005). The first documented toxic bloom occurred in Copco Reservoir on September 29th 2004 when 1.9 million cells/ml of MSAE were associated with a microcystin toxin concentration of 482 µg/L. Microcystin is a potent hepatotoxin capable of causing chronic liver damage and acting as a tumor promoter (Carmichael 1995; Chorus et al. 1999; Chorus 2001). Copco and Iron Gate Reservoir data clearly showed the occurrence of large and widespread blooms of MSAE and microcystin toxin levels in 2005 (Kann 2005: shown here in Fig 1). During the July-September period, cell density and toxin levels exceeded the World Health Organization (WHO) Moderate Probability of Adverse Health Effect Level (MPAHEL) often by 10-100's of times; likewise, the Tolerable Daily Intake (TDI—see Kann [2005] for description) was also commonly exceeded by more than 10-100 times throughout the July-September period (Fig. 1).

These data also showed that during the same sample dates when in-reservoir data (the boxes in Fig. 1a and 1b) showed substantial MSAE cell density and toxin concentration, the Klamath River directly above the reservoirs (station KRAC) showed non-detects for both parameters (red circles in Fig. 1a and 1b). Comparatively, the station directly below the reservoirs (station KRBI) exhibited positive MSAE concentrations during this same period (Fig. 1).

From these empirical observations and given the extremely high concentrations of both MSAE density and microcystin toxin in the reservoirs in 2005, it appears that both reservoirs provided ideal growing conditions for MSAE relative to the Klamath River directly upstream (Kann 2005 and Fig. 2 below).

Partly in response to statements by PacifiCorp that MSAE is already frequent and abundant in the system upstream from Copco and Iron Gate (e.g., see response by PacifiCorp [Appendix I with added comment by Kann] to a letter submitted to FERC by California State Water Resources Board [Appendix 2II), and that the reservoirs only reflect this upstream abundance, the Yurok Tribe Environmental and Fisheries Programs contracted with Aquatic Ecosystem Sciences to use available data to evaluate MSAE longitudinal trends in the Klamath River.

The purpose of this technical memorandum is to provide a brief summary of MSAE in the Klamath River System using the following data sets: Klamath Tribes data from Upper Klamath Lake (1990-1997), PacifiCorp data from the outlet of UKL to the Klamath River at I5 (2001-2004), Karuk Tribe/CA State Water Resources Board (SWRB) data for the Copco Iron Gate reservoir system (2005), and Yurok Tribe/US Fish and Wildlife Service (USFWS) data from below Iron Gate Reservoir to the Klamath River estuary (2005).

DATA EVALUATION and TRENDS

Klamath Tribes Upper Klamath Lake (UKL) Data

The Klamath Tribes collected biweekly phytoplankton samples from a variety of stations in UKL and Agency Lake from 1990-1997 (Fig. 3). These data are shown in electronic Appendix E1 and

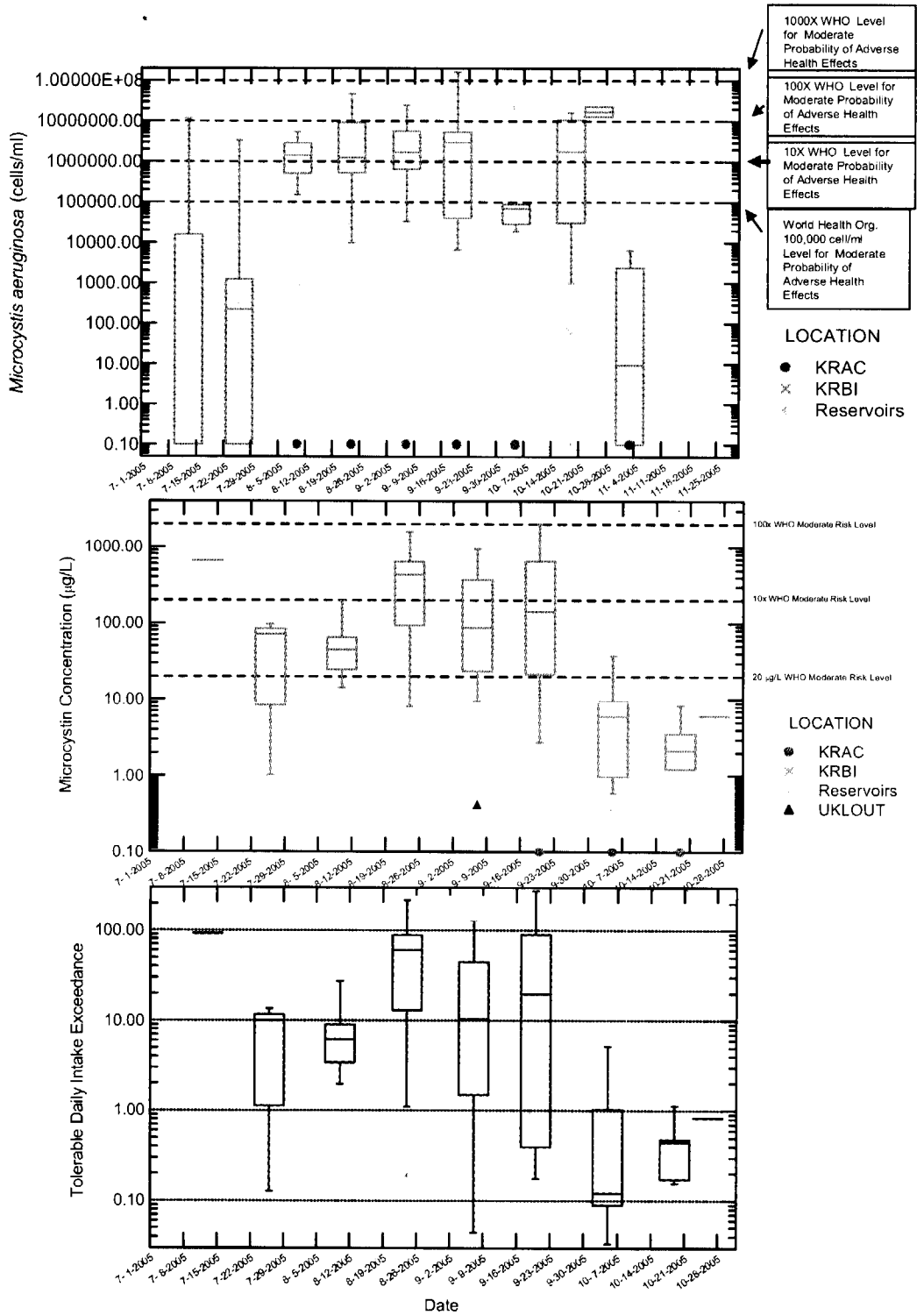


Figure 1. Karuk Tribe/SWRB *Microcystis aeruginosa* cell density (a), microcystin concentration (b), and TDI for all reservoir stations combined (c) in Copco and Irongate Reservoirs, July-October, 2005. Note y-axis is log scaled and for graphing purposes all values have 0.1added to them; Reservoirs=Copco and Iron Gate, KRAC=Klamath R. above Copco Reservoir, KRBI=Klamath R. below Iron Gate Reservoir, UKOUT=UKL outlet (sampled on one occasion). From Kann (2005).

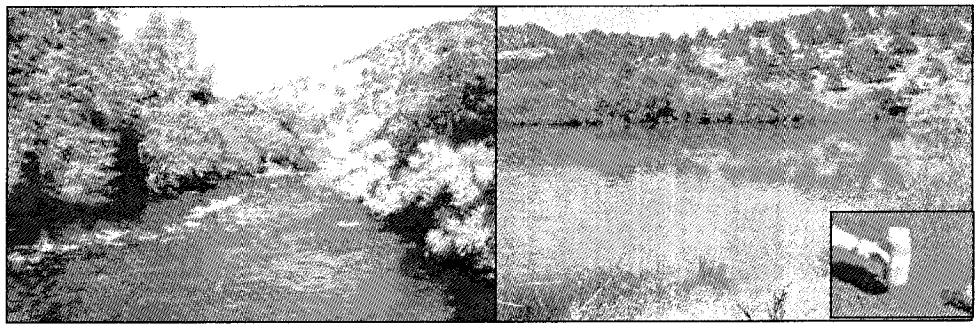


Figure 2. Photos of the Klamath River Station KRAC and an MSAE bloom occurring near the confluence of Jenny Creek in Iron Gate Reservoir, 2005.

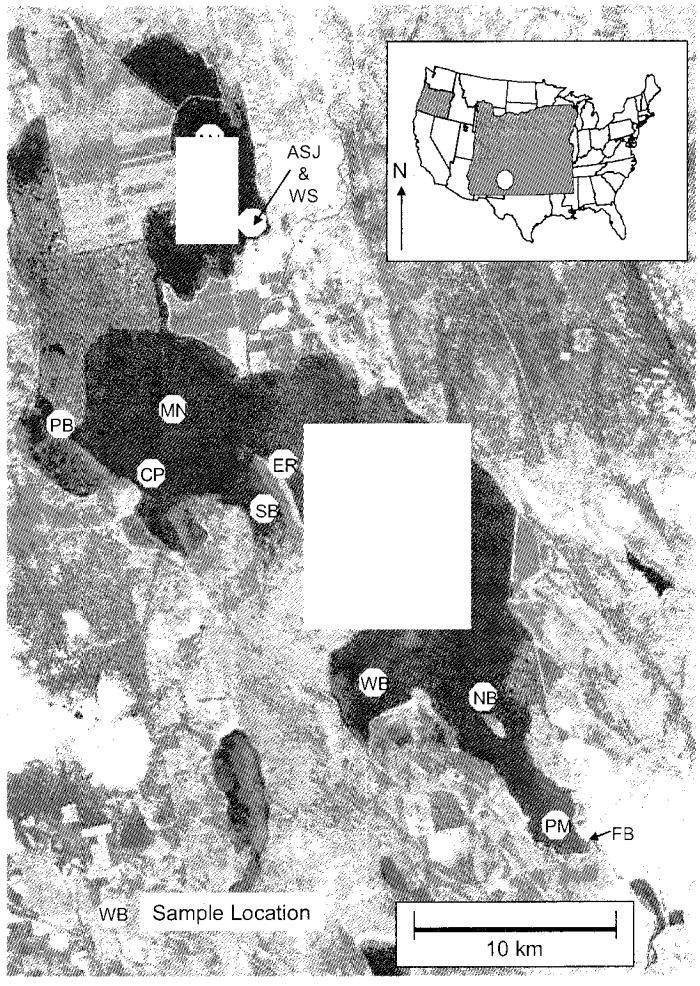


Figure 3. Sample station location for Upper Klamath and Agency Lake phytoplankton collections made by the Klamath Tribes between 1990 and 1997.

sample methods are outlined in Kann (1998). Because MSAE cell density was not reported for the UKL data set, MSAE colony density was also evaluated so that a common measurement unit could be compared among the UKL, PacifiCorp, and Karuk data sets. UKL samples represent an integrated water column sample generally ranging between 2-3 meters. MSAE biovolume and colony density values were converted from a per liter basis to a per mL basis to facilitate comparison among data sets. These data show that MSAE is clearly present in UKL and Agency Lakes (Figures 4a and 5a).

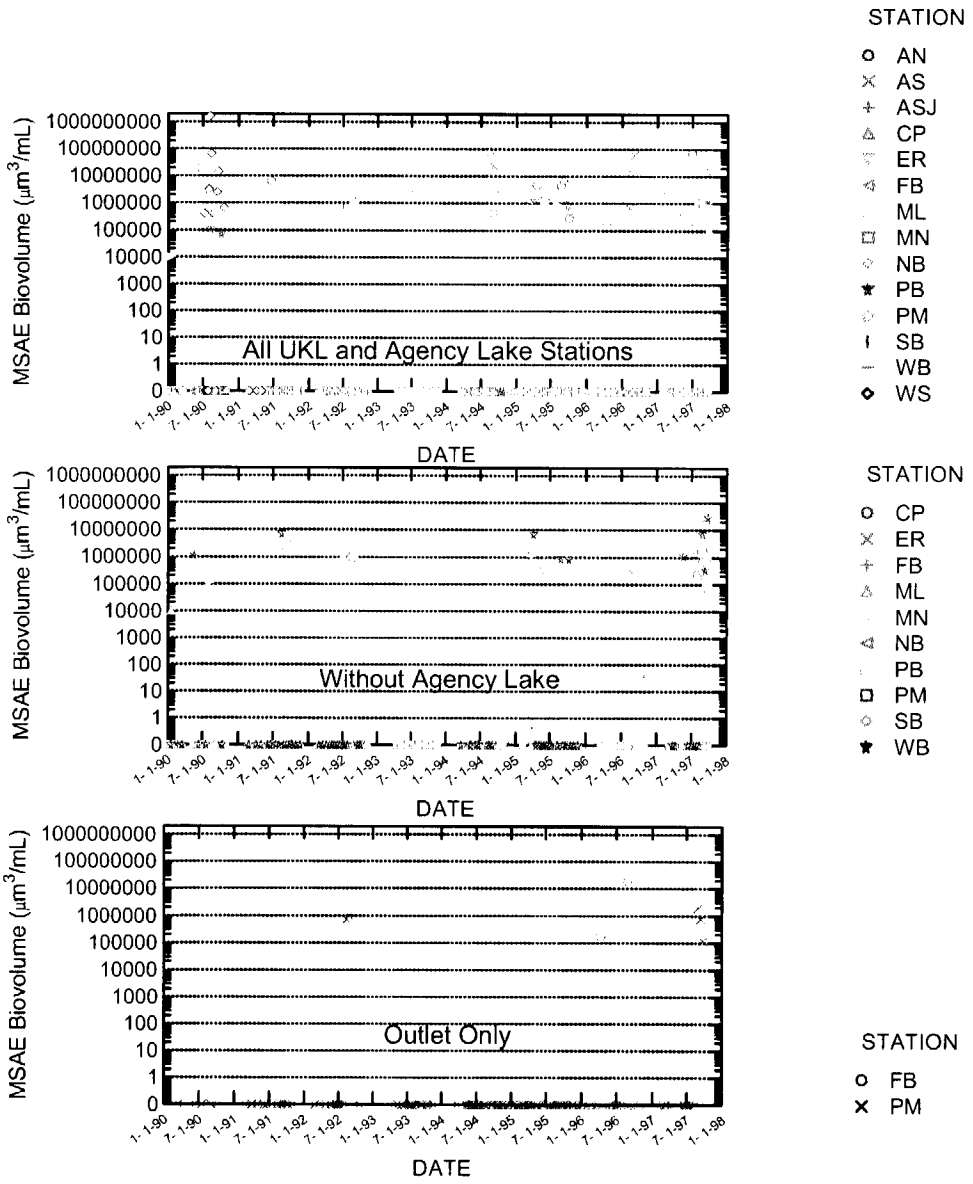


Figure 4. Klamath Tribes *Microcystis aeruginosa* biovolume at all UKL and Agency Lake stations (a), at UKL stations only (b), and for outlet stations only (c), 1990-1997. Note y-axis is log scaled and for graphing purposes all values have 0.1 added to them.

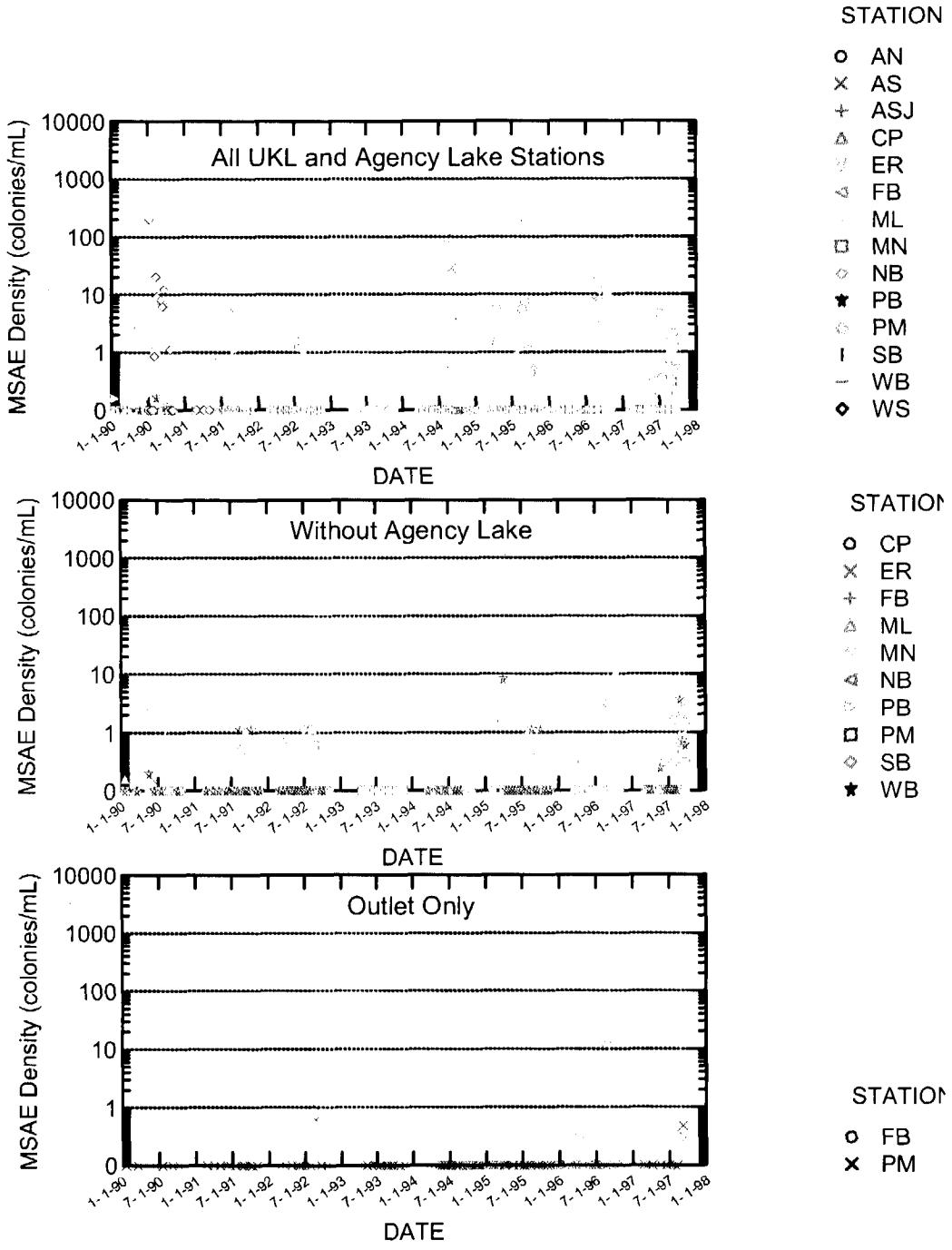


Figure 5. Klamath Tribes *Microcystis aeruginosa* colony density at all UKL and Agency Lake stations (a), at UKL stations only (b), and for outlet stations only (c), 1990-1997. Note y-axis is log scaled and for graphing purposes all values have 0.1 added to them.

However, many of the high biomass and high colony density occurrences were found in Agency Lake, and when these stations (AN, AS, ASJ, and WS) are excluded, maximum values drop substantially (Figures 4b and 5b). In fact, colony density values were rarely greater than10 colonies/mL for UKL only (Figure 5b), and exceeded 1 colony per/mL only 13 in 537 samples, or 2.4% of sample collections during the July-October period over 8 years (Table 1). The percent of all UKL samples where MSAE was detected in this period was 12.8% (Table 1). Given the dominance in UKL by another cyanobacterial species, *Aphanizomenon flos-aquae*, this is not unexpected.

Moreover, because a relevant question is the amount of MSAE leaving UKL and entering the Klamath River (via the Link River), Figure 5c shows MSAE only at PM (Pelican Marina) and FB (Fremont Bridge), stations near the outlet of UKL (Figure 3). It is clear from this figure that there were very few instances when MSAE density exceeded 1 colony/mL, and over the 8-year period there was only 1 incidence in 77 sample collections (1.3%) during July-October when these stations exceeded 1 colony/mL.

Table 1. *Microcystis aeruginosa* (MSAE) occurrence in Upper Klamath Lake (UKL) and Agency Lake phytoplankton samples collected July-October, 1990-1997[1]. The July-October period was chosen because this corresponds to MSAE occurrences downstream.

Sample Station Description	Total # of Samples Collected 1990-1997	Total # of Samples with MSAE	% of Samples with MSAE	Total # of Samples with MSAE > 1 colony/mL	% of Samples with MSAE > 1 colony/mL
All UKL and Agency L. Sample Stations	685	100	14.6%	35	5.1%
UKL Stations Only	537	69	12.8%	13	2.4%
Outlet Stations Only (PM and FB)	77	9	11.7%	1	1.3%

[1]Data collected by the Klamath Tribes; methodology described in Kann (1998).

MSAE clearly exists in UKL and Agency Lakes and is known to form periodic blooms in both systems, but particularly in Agency Lake (e.g., a toxic algae advisory was issued for Agency Lake by the OR Dept. of Human Services in August of 1996). However, despite the initial appearance of frequent and abundant MSAE occurrence in UKL, when data are filtered by excluding Agency Lake and by evaluating only what is leaving UKL and entering the Klamath River system, both occurrences and density were relatively low (generally< 1 colony/mL).

PacifiCorp Klamath River Data

Between 2001-2004 PacifiCorp collected ~monthly phytoplankton samples from stations beginning at the outlet of UKL and ending where the Klamath River crosses I5 (Figure 6). These data are shown in electronic Appendix E2 and sample methods are outlined in Raymond (2005).Station descriptions are shown in Table 2 along with years sampled and graph station code used in subsequent figures. The only station directly below UKL with significant sampling frequency over several years was Link River at Mouth (KR25312), UKL at Fremont Bridge was only sampled 2x in 2002, Lake Ewauna was sampled on only one date in 2003, and KR at Keno Bridge was sampled 4x in 2003 (Table 2). A longitudinal comparison of stations (particularly those with multiple years of data; Table 2, Figures 7 and 8) shows a similar trend to those noted for the UKL (Figure 5c above) and Karuk (Figure 1 above) data sets.

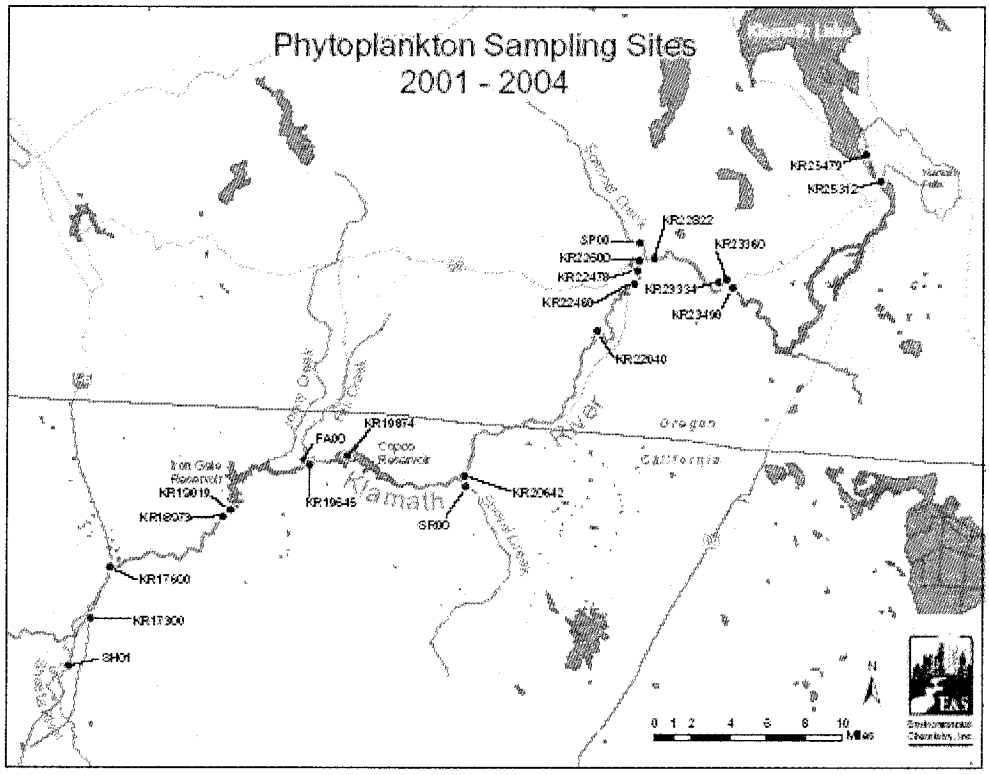


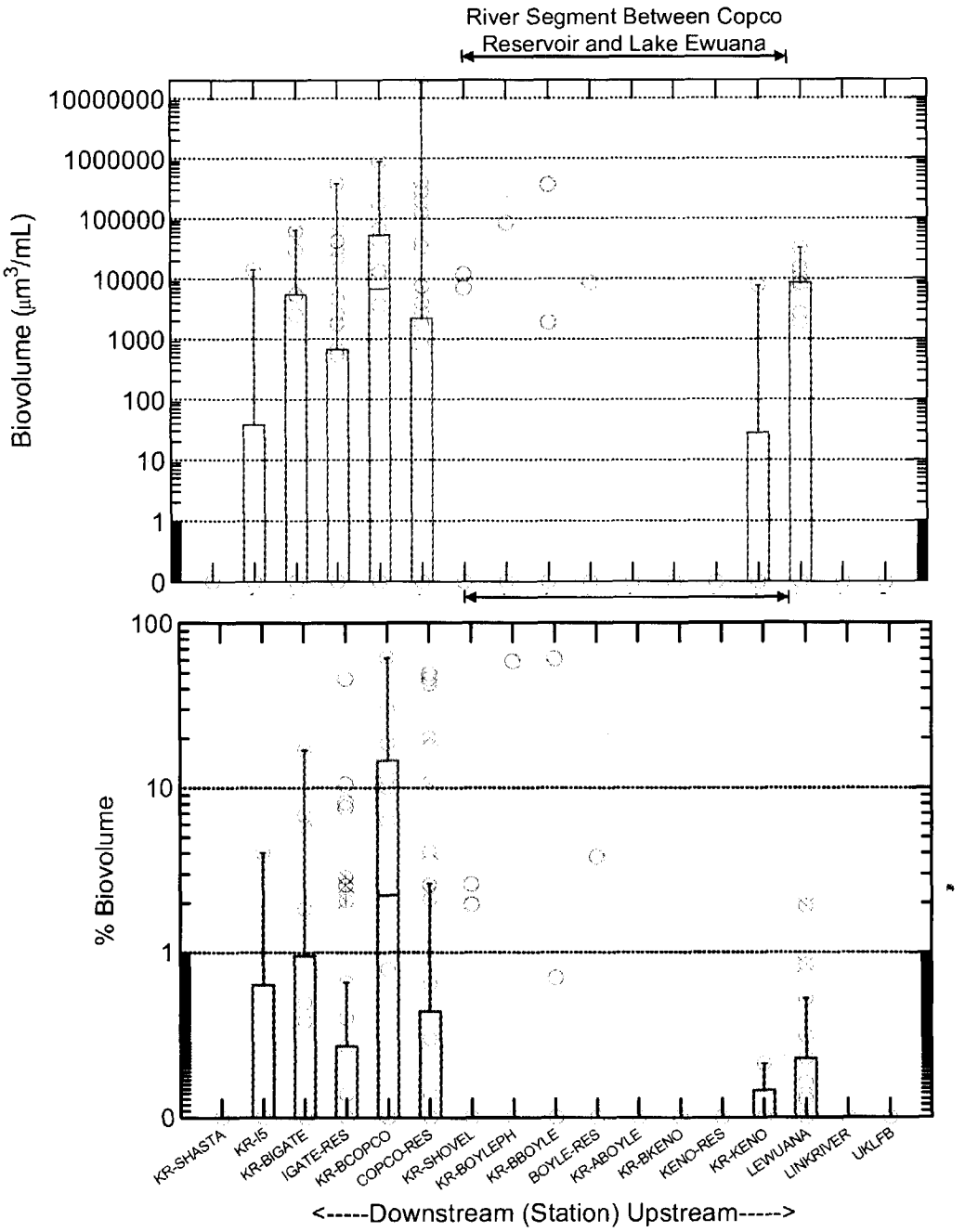
Figure 6. PacifiCorp phytoplankton samples collected in the vicinity of the Klamath Hydroelectric Project, 2001-2004 (Figure excerpted from Raymond (2005); E & S Environmental Chemistry, Inc Technical Memorandum: Methods and Data for PacifiCorp Phytoplankton Sampling in the Klamath River System, 2001-2005.

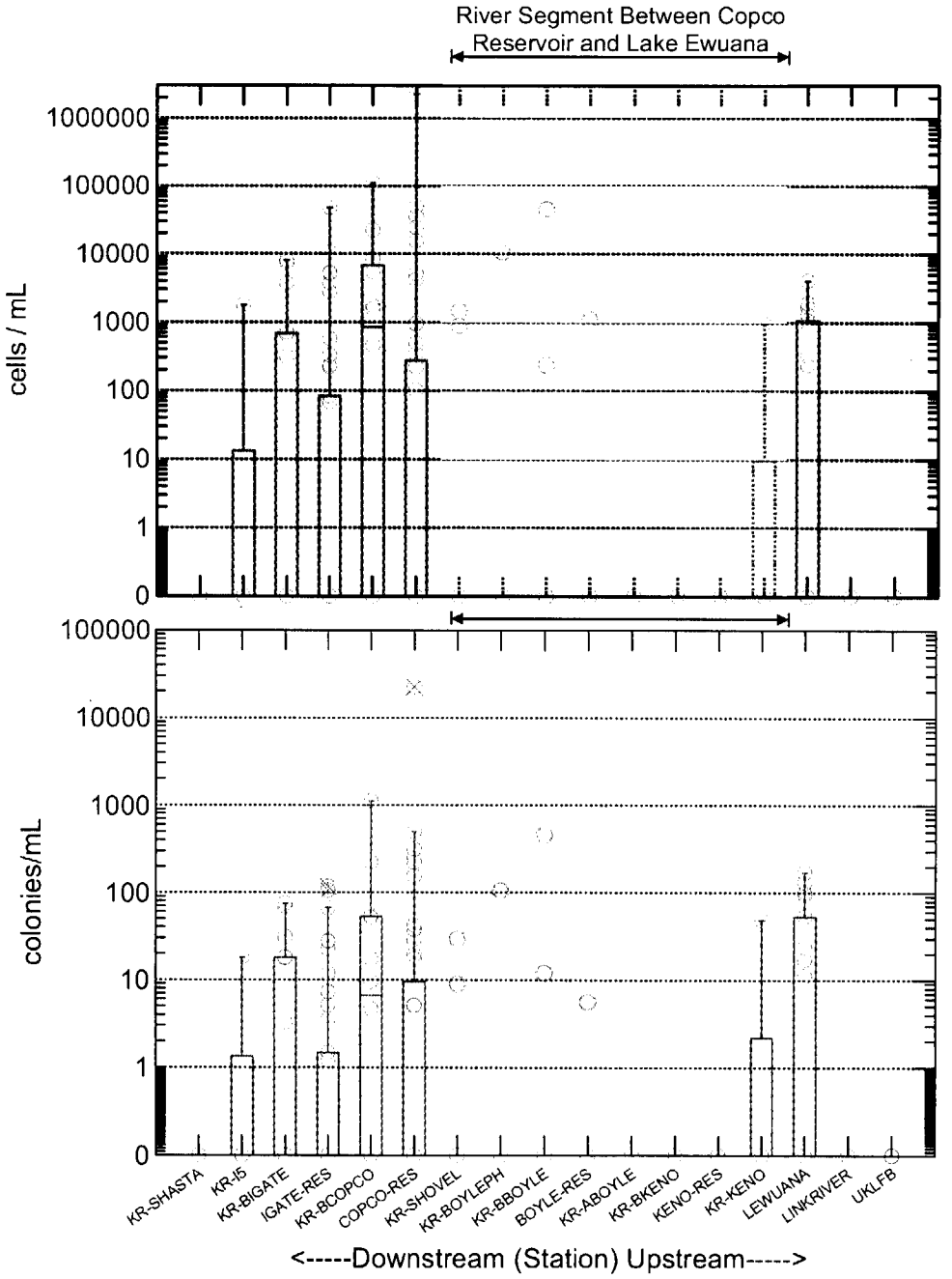
Table 2. ***Microcystis aeruginosa*** **(MSAE) occurrence in PacifiCorp phytoplankton samples collected July-October in the vicinity of the Klamath Hydroelectric Project, 2001-2004[1]. The July-October interval is shown here because *Microcystis aeruginosa* was not detected in any samples earlier than July or later than October.**

PacifiCorp Site ID	River Mile	Site Name	Graph Station Code	Total # of samples collected	Years Sampled	Total # of samples with MSAE	% of samples with MSAE	Total # of MSAE samples > 10,000 cells/ml
KR17300	173.00	Klamath River above Shasta River	KR-SHASTA	4	2002	0	0%	0
KR17600	176.00	Klamath River at I-5 Rest Area	KR-I5	3	2004	1	33%	0
KR18973	189.73	Iron Gate dam Outflow	KR-BIGATE	15	2001-2004	6	40%	0
KR19019	190.19	Iron Gate reservoir near dam	IGATE-RES	41	2001-2004	12	29%	2
KR19645	196.45	Copco 2 dam Outflow	KR-BCOPCO	12	2002-2004	7	58%	2
KR19874	198.74	Copco reservoir	COPCO-RES	43	2001-2004	13	30%	5
KR20642	206.42	Klamath River upstream of Shovel Creek	KR-SHOVEL	17	2001-2004	2	12%	0
KR22040	220.40	Klamath River upstream of J.C. Boyle Powerhouse	KR-BOYLEPH	13	2002-2004	1	8%	1
KR22460	224.60	Klamath River below J.C. Boyle dam	KR-BBOYLE	13	2001-2004	2	15%	1
KR22478	224.78	J.C. Boyle reservoir at Log Boom	BOYLE-RES	20	2001-2003	1	5%	0
KR22822	228.22	Klamath River above J.C. Boyle reservoir	KR-ABOYLE	12	2002-2004	0	0%	0
KR23334	233.34	Keno dam Outflow	KR-BKENO	12	2002-2004	0	0%	0
KR23360	233.60	Keno reservoir at Log Boom	KENO-RES	7	2001	0	0%	0
KR23490	234.90	Klamath River at Keno Bridge (Hwy 66)	KR-KENO	4	2003	1	25%	0
L. Ewauna	[2]	Lake Ewauna	LEWAUNA	18	2003	8	44%	0
KR25312	253.12	Link River at Mouth	LINKRIVER	19	2002-2004	0	0%	0
KR25479	254.79	Upper Klamath Lake at Fremont St Bridge	UKLFB	2	2002	0	0%	0

[1]Pacificorp data and methods obtained from E & S Environmental Chemistry, Inc Technical Memorandum: Methods and Data for PacifiCorp Phytoplankton Sampling in the Klamath River System, 2001-2005

[2]Specific station location not provided for Lake Ewauna (all data collected on one date-- August 20, 2003).


River Segment Between Copco Reservoir and Lake Ewuana
Biovolume (µm3/mL)
10000000
1000000
100000
10000
1000
100
10
1
0
% Biovolume
100
10
1
0
KR-SHASTA
KR-I5
KR-BIGATE
IGATE-RES
KR-BCOPCO
COPCO-RES
KR-SHOVEL
KR-BOYLEPH
KR-BBOYLE
BOYLE-RES
KR-ABOYLE
KR-BKENO
KENO-RES
KR-KENO
LEWUANA
LINKRIVER
UKLFB
<-----Downstream (Station) Upstream----->
Figure 7. PacifiCorp MSAE biovolume (a) and percent biovolume (b) trends in the vicinity of the Klamath Hydroelectric Project, 2001-2004.


River Segment Between Copco Reservoir and Lake Ewuana
cells / mL
1000000
100000
10000
1000
100
10
1
0
colonies/mL
100000
10000
1000
100
10
1
0
KR-SHASTA
KR-I5
KR-BIGATE
IGATE-RES
KR-BCOPCO
COPCO-RES
KR-SHOVEL
KR-BOYLEPH
KR-BBOYLE
BOYLE-RES
KR-ABOYLE
KR-BKENO
KENO-RES
KR-KENO
LEWUANA
LINKRIVER
UKLFB
<-----Downstream (Station) Upstream----->
Figure 8. PacifiCorp MSAE cell density (a) and colony density (b) trends in the vicinity of the Klamath Hydroelectric Project, 2001-2004. Cell density is computed by dividing the biovolume by 8 μm3 - the cell size factor utilized by Aquatic Analysts to compute biovolume (Jim Sweet, pers. comm.).

Similar to the trend of low to no MSAE leaving UKL between 1990-1997 (Figure 5c), PacifiCorp data near the outlet of UKL (Link River at Mouth) showed no detection of MSAE in 19 samples (0%) collected between July-October, 2002-2004 (Table 2, Figures 7 and 8). MSAE was detected in Lake Ewauna and KR at Keno Bridge in 2003, with maximum colony density at ~200 colonies/mL in Lake Ewauna (Figure 8). As noted in Table 2, no location information was provided for this station, and all data were collected on only one date.

Moving downstream, there was no MSAE detected in 24 combined samples collected at the Keno Dam Outflow and the above J.C. Boyle Reservoir stations (Table 2; Figure 8). In the system including Boyle reservoir, below Boyle and the Boyle Powerhouse there were several positive detections (5-15% of measurements; Table 2) indicating possible re-growth of MSAE in the J.C. Boyle Reservoir environment.

In the Klamath river upstream of Shovel Creek (KR-Shovel, which is equivalent to KRAC of the Karuk study—see above Figure 1) only 2 in 17 measurements (12%) showed positive detection for MSAE in the 2001-2004 July-October period, with a maximum of 30 colonies/mL (Figure 8b).

In the Copco/Irongate portion of the KHP system the incidence and magnitude of MSAE clearly increases compared to upstream Klamath River stations (shaded area of Figures 7 and 8). In the reservoirs proper (COPCO-RES and IGATE-RES) and in the river directly below them (KR-BCOPCO and KR-BIGATE), the percent of samples with positive MSAE ranged between 29% and 58% (Table 2). Reservoir samples represent variable depths (sometimes representing a 10m integrated sample or a specific depth such as 0.1m, 0.5m, or 8m), such that a buoyant species like MSAE would be expected to be lower in density at deeper depths. Nonetheless, the Copco/Irongate reservoir system showed significant prevalence of MSAE, especially relative to Klamath River stations directly above the reservoirs. Colony density commonly approached 100 colonies/mL and exceeded 1000 colonies/mL on several occasions (Figure 8b). Furthermore, the only stations exhibiting cell densities greater than 10,000 cells/mL anywhere in the system were the reservoir stations or the river directly below them (Table 2).

Two PacifiCorp samples taken, one in 2003 (see max value of ~18 million cell/mL or ~20,000 colonies/mL for COPCO-RES in Figure 8) and one in 2005 (max ~ 6.6 million cells/mL; data not shown) are from additional (non-routine) samples that were taken from concentrated areas of localized algal blooms at the water surface (see Electronic Appendix E2). These data indicate the potential for extreme surface blooms of MSAE in the reservoirs, and are similar to values measured in the Karuk study (see Figure 1 above).

Similar to the Karuk 2005 data set and the Klamath Tribes UKL data set, the PacifiCorp data set described here shows low incidence and magnitude of MSAE leaving UKL (e.g., compare Link River with UKL outflow) and in the Klamath River above Copco Reservoir (e.g., compare KR-SHOVEL with KRAC), and high incidence and magnitude in Copco and Irongate Reservoirs.

Karuk/SWRB Copco/Iron Gate Reservoir System Data

Although shown above in Figure 1, Karuk Tribe/SWRB data are described in additional detail here. During the 2005 sample season, samples were collected biweekly from a variety of shoreline and open-water stations, including the standard open-water locations: IR01 and CR01 (Fig. 9).

Copco and Iron Gate Reservoir Sampling Locations

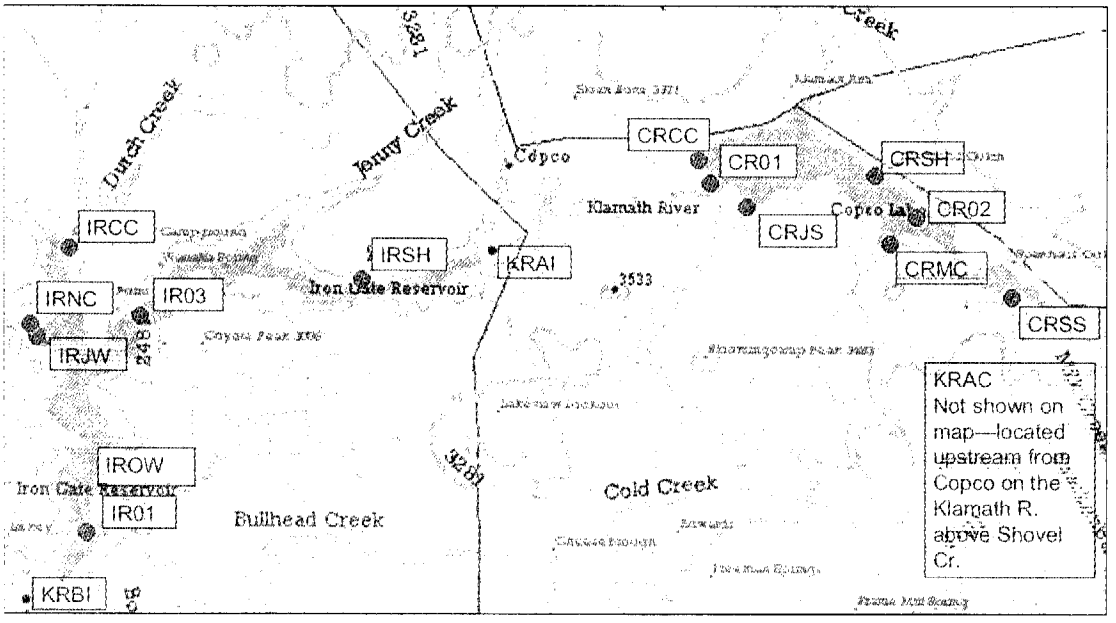


Figure 9. Karuk Tribe/SWRB sample station locations in the Copco/Iron Gate Reservoir system, 2005.

CR01 and IR01 are equivalent to the standard PacifiCorp reservoir stations KR19874 and KR19019 (see Table 2 above). Stations IR01, IR03, and CR01 are open-water locations and were sampled biweekly as part of an ongoing Karuk/SWRB reservoir nutrient loading study. Other stations were routinely sampled biweekly specifically to assess the extent of toxic MSAE, and as described above, the stations KRAC and KRBI are Klamath River stations above Copco (KRAC) and Below Iron Gate (KRBI). The majority of samples analyzed here represent surface grab samples, and as such are not directly comparable to PacifiCorp samples taken at depth or that are integrated over the water column (however see two exceptions noted above).

A representation of all measured 2005 stations grouped by system further illustrates the non-detection of MSAE in the Klamath River above Copco (KRAC), frequent and extreme MSAE values in the reservoirs, and lower but significant values below the reservoirs at KRBI (Figure 10). Similar to the PacifiCorp data, the frequency and abundance of reservoir MSAE colonies/mL was vastly greater than that measured upstream in the PacifiCorp and Klamath Tribes UKL data. Although the years do not

overlap in the respective studies, the fact that KRAC showed non-detects for MSAE in 2005 provides evidence that trends are similar among the studies.

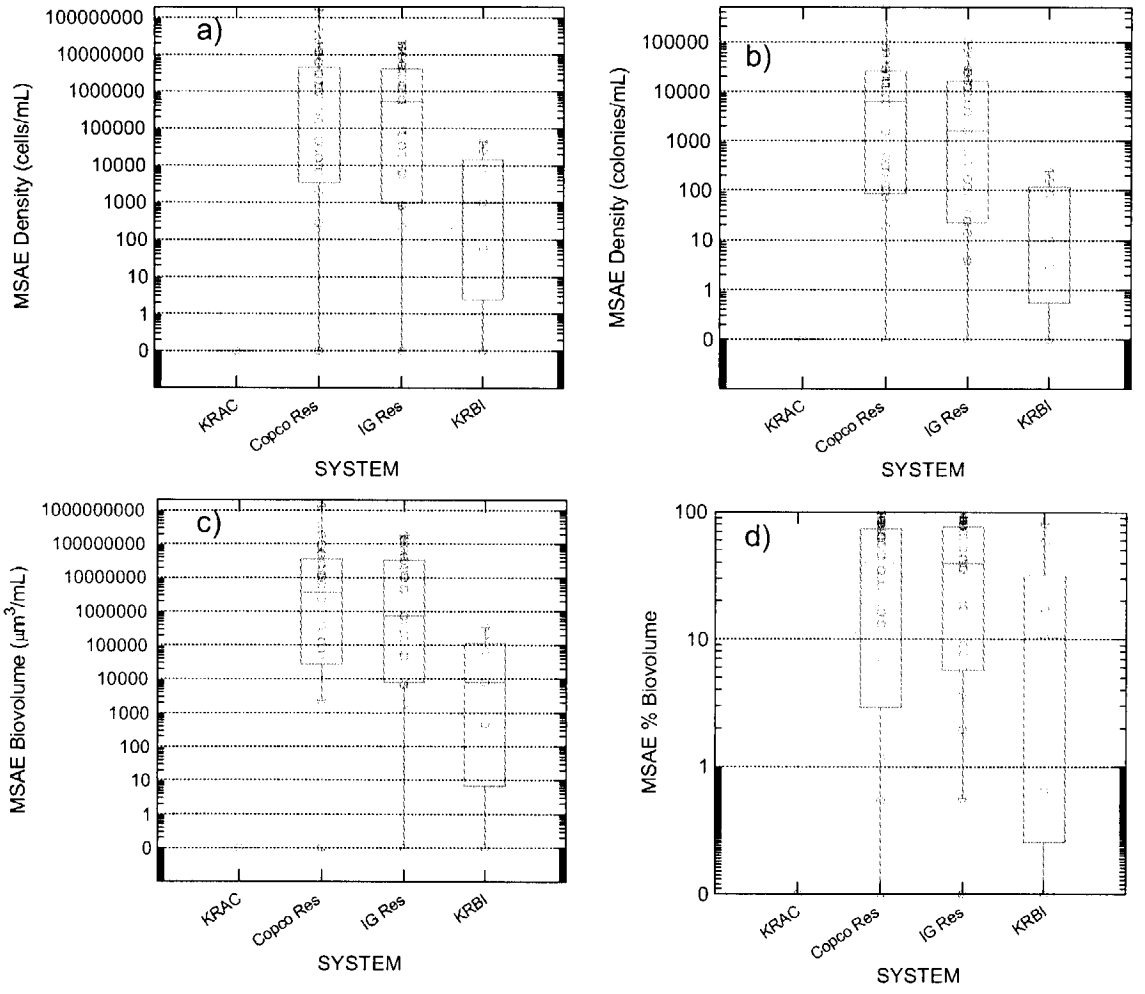


Figure 10. Karuk Tribe/SWRB MSAE cell density (a), colony density (b), biovolume (c), and % biovolume (d) in the Klamath River and Copco and Irongate Reservoirs, July-October 2005.

In contrast to the Klamath River upstream (KRAC; 0%), 87.5% and 89.7% of the samples were positive for MSAE in Copco and Iron Gate, respectively (Figure 10). In fact, 50% and 41.4% of the samples exceeded 10,000 colonies/mL (Figure 10b). If only the PacifiCorp equivalent stations (CRO1 and IR01) are evaluated, the percent of samples exceeding 10,000 colonies/mL is still 30% and 37.5%, respectively. These reservoir values are vastly greater than those upstream, even when compared to those measured in Agency Lake (e.g., see Figure 4a).

Although data indicate MSAE is in the system upstream from Copco and Iron Gate Reservoirs, both the PacifiCorp and Karuk/SWRB data clearly indicate large increases in MSAE in the reservoirs relative to the Klamath River upstream.

Yurok Tribe/USFWS Klamath River Data

During the 2005 sampling period encompassing the above reservoir data, the Yurok Tribe and USFWS sampled a variety of Klamath River stations from below Iron Gate Reservoir to the Klamath River Estuary (Fig 11). Methods and complete results are contained in Fetcho (2006). Station codes corresponding to graphs are shown in Table 3.

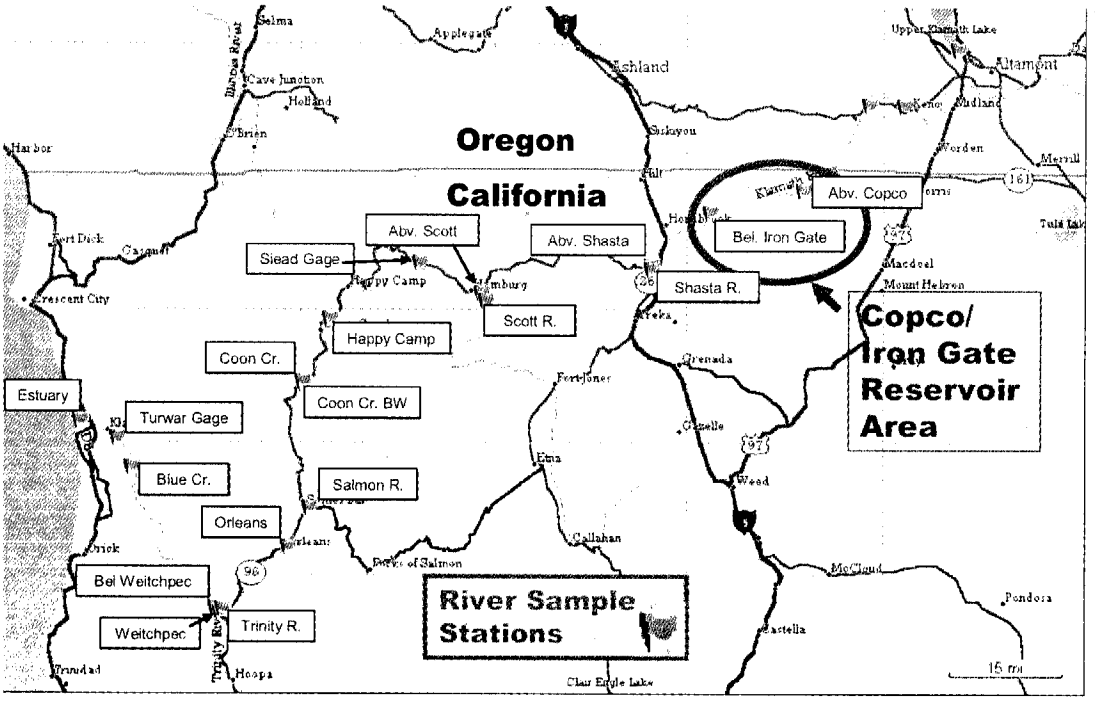


Figure 11. Location of Yurok/USFWS Klamath River sampling stations, 2005.

Table 3. Station codes corresponding to Yurok/USFWS sampling stations on the Klamath River below Irongate Reservoir.

Below Link River Dam	BLRD
Below Keno Dam	KRBK
Below JC Boyle Dam	KRBB
KR Above Copco	KRAC
KR @ Below IG	KRBI
Abv Shasta R.	KRASH
Abv Scott R.	KRASC
Siead Gage	KRSG
Happy Camp	KRHC
Orleans	KROR

Cont.

Weitchpec (abv TR)	KRWE
Below Weitchpec	KRBW
Turwar Gage	KRTG
KR Estuary	KREST
Shasta R.	SHASTA
Scott R.	SCOTT
Salmon R.	SALMON
Trinity R.	TRINITY
KR Above Coon Creek River Access	KRACOON
Backwater pool at Coon Creek River Access	KRCOONB
Edgewater Below Blue Creek	EDGEBBC

Given the above Karuk Tribe/SWRB data showing an increase in MSAE and microcystin toxin from above Copco Reservoir to below Iron Gate Reservoir (KRBI), the potential exists for export of both cells and toxin to downstream environments. Apparent downstream blooms were noted in August of 2005, and Figure 12 shows a micrograph of a typical MSAE colony from a collection made by USFWS (written comm. Randy Turner) at Weitchpec, well downstream on the Klamath River (Figure 11).

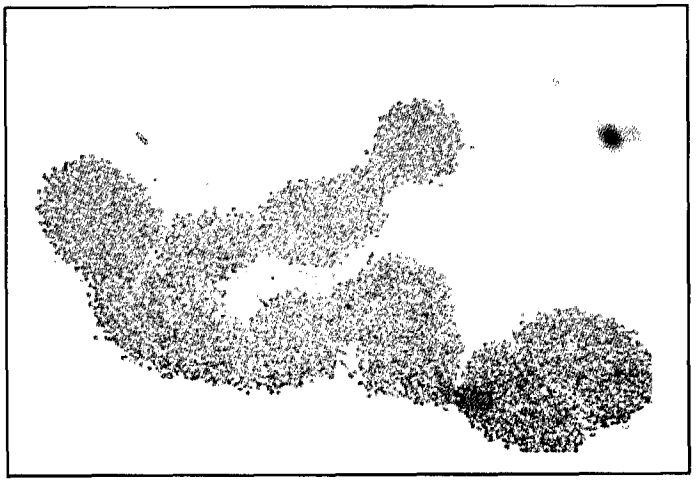


Figure 12 Micrograph of a *Microcystis* colony in the Klamath River at Weitchpec, 2005; USFWS- Randy Turner/Paul Zedonis.

A plot of Yurok Tribe/USFWS stations below Iron Gate Reservoir shows the continued downstream presence of MSAE at all stations, including the Klamath River estuary (Figure 13; KREST). Although cell densities did not exceed the WHO MPHAHE level of 100,000 cell/mL, densities frequently exceeded 10,000 cells/mL (Figure 13).

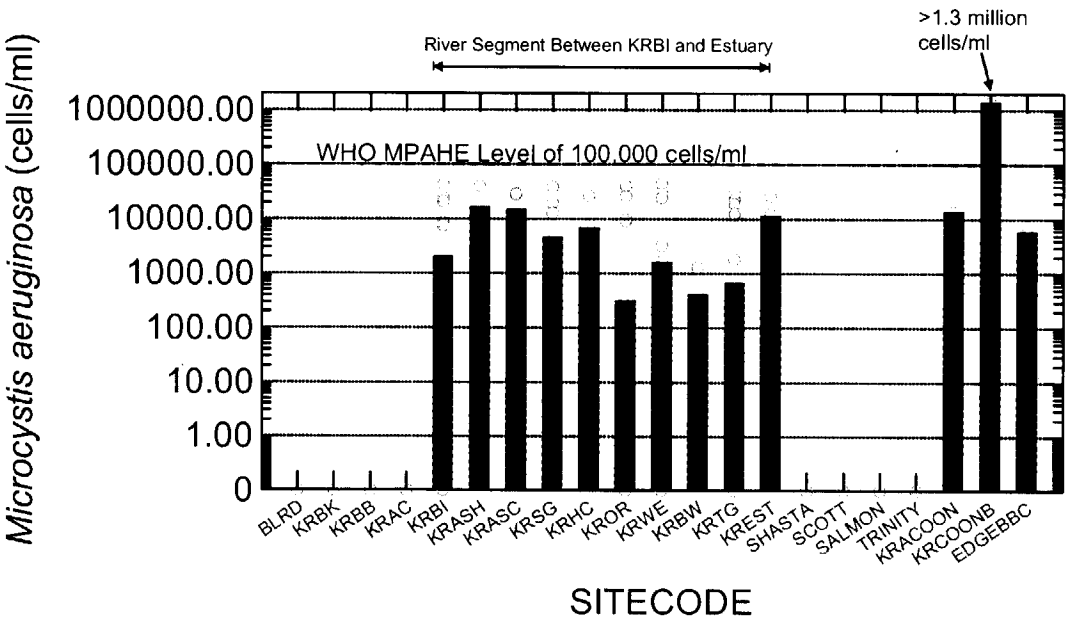


Figure 13. Yurok Tribe/USFWS MSAE cell density trends in the Klamath River system, 2005. Stations from KRBI to KREST are ordered from upstream on the left to downstream on the right. Blue bars are station means and red circles are individual data points.

This is in contrast to the PacifiCorp 2001-2004 data for Klamath River stations above the Copco/Iron Gate reservoirs, where the only stations exceeding 10,000 cells/mL were those in the reservoirs or directly below (Table 2). Although the PacifiCorp study years do not overlap with these data, the Karuk/SWRB data for 2005 shows no values exceeding 10,000 cells/mL above Copco at KRAC; and in fact, shows that MSAE was not detected at all at this station (Figure 10) during the same period encompassing the Yurok/USFWS data collection effort.

In addition, MSAE cell concentration exceeded 1.3 million cells/ml in a backwater area near the confluence of Coon Creek nearly 100 miles downstream from Iron Gate Dam (KRCOONB; Figure 13). The lowest detected microcystin level, 0.2 µg/L, was measured at the KRTG site on September 21, 2005, and the highest microcystin level, 6.25 µg/L, was measured at the KRWE site on September 8, 2005 (Fetcho 2006).

The Yurok Tribes Environmental and Fisheries Programs also conducted fish tissue analyses on select Chinook salmon and steelhead from the lower Klamath River in 2005. These limited results indicate that of 9 adult salmon liver and muscle samples from Weitchpec and Iron Gate Hatchery, all were below the detection limit of 0.147 ppb; of 2

Steelhead (one adult and one ½ pounder) muscle samples from Weitchpec, both were below the detection limit of 0.147 ppb; and of 2 Steelhead (one adult and one half-pounder) liver samples from Weitchpec the adult had a trace amount of 0.17 ppb and the ½ pounder had 0.54 ppm (µg/g) (Table 4).

Table 4. From Fetcho (2006): Microcystin results for fish tissue samples collected within Yurok Reservation boundaries, Water Year 2005.

Date	Site	Tissue Type	Species	Microcystin µg/g	Sampling Crew
9/13/2005	KBW	Liver	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Filet	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Liver	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Filet	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Liver	Chinook salmon	BDL	YTFP
9/30/2005	IG	Male Liver	Chinook salmon	BDL	CDF&G
9/30/2005	IG	Male filet	Chinook salmon	BDL	CDF&G
9/30/2005	IG	Female Liver	Chinook salmon	BDL	CDF&G
9/30/2005	IG	Female Filet	Chinook salmon	BDL	CDF&G
10/03/205	WE	Adult Liver	Steelhead	Trace	YTFP
10/03/205	WE	Adult Filet	Steelhead	BDL	YTFP
10/03/205	WE	1/2 pounder Liver	Steelhead	0.54	YTFP
10/03/205	WE	1/2 pounder Filet	Steelhead	BDL	YTFP

KBW=Klamath River Below Weitchpec
WE=Klamath River at Weitchpec
IG=Klamath River Iron Gate Hatchery
YTFP=Yurok Tribe Fisheries Program
CDF&G=California Dept. of Fish and Game
BDL=Below Detection Limit (0.147 µg/L)
Trace=(0.17 µg/L)

Although sample size is limited, low to trace quantities of microcystin in steelhead livers in the lower Klamath River indicate that these fish were exposed to toxin levels in the river environment, and indicate the potential for toxin uptake to occur. Steelhead residing in the Klamath River at the time of sampling would have increased exposure time relative to salmon.

The 2005 Yurok Tribe/USFWS data for the lower Klamath River show the continued presence of MSAE and associated microcystin toxin in the river below Iron Gate Dam. Although mean values tend to decrease downstream from KRBI, MSAE values were still higher and more frequent than those upstream from Copco Reservoir. These data provide a clear indication that MSAE presence in the lower river is a function of increased inoculums from the massive MSAE growth occurring in Copco and Iron Gate Reservoirs.

CONCLUSIONS

Several lines of evidence point to the role of the KHP Copco and Iron Gate Reservoirs in providing ideal habitat conditions for MSAE. First, although MSAE clearly exists in UKL and Agency Lakes and is known to form periodic blooms in both systems, when data are filtered by excluding Agency Lake and by evaluating only what is leaving UKL

and entering the Klamath River system, occurrences were rare and density very low over an 8-year period (generally< 1 colony/mL); especially in contrast to MSAE values commonly exceeding 10,000 colonies/mL in Copco and Iron Gate Reservoirs.

Second, similar to the Karuk/SWRB 2005 data set and the Klamath Tribes UKL data set, the PacifiCorp data set described above showed low incidence and magnitude of MSAE leaving UKL and in the Klamath River above Copco Reservoir, and high incidence and magnitude in Copco and Irongate Reservoirs.

Third, MSAE was not detected at KRAC (above Copco reservoir) during the Karuk/SWRB 2005 data collection effort, even when reservoir stations showed substantial concentrations of both toxin and MSAE cell density. In contrast to the Klamath River upstream, 87.5% and 89.7% of the samples were positive for MSAE in Copco and Iron Gate, respectively.

Fourthly, as indicated by cell count and toxin values at KRBI and in the Yurok/USFWS data that were higher than those measured in the Klamath River upstream from the reservoirs, export from the reservoirs of both cells and toxin to downstream environments is occurring.

These data are consistent with literature showing that MSAE and other buoyant cyanobacteria do not dominate in conditions of turbulent mixing such as that known to occur in the Klamath River above Copco and Iron Gate Reservoirs. For example, Huisman et al. (2004) demonstrate that potentially toxic MSAE dominate at low turbulent diffusivity (calm-stable conditions) when their flotation velocity exceeds the rate of turbulent mixing. Such conditions are more likely to occur in lakes and reservoirs as velocity and turbulence are reduced. In addition, MSAE has been shown in numerous studies to be favored in lake and reservoir environments that tend to be warmer and less turbulent than riverine ones (Reynolds 1986).

In areas where turbulent diffusivity may decrease as rivers widen and increase in depth, or such as would occur in backwater areas, the potential also exists for MSAE blooms in slow-moving riverine environments as well. In addition, others have noted a linkage between MSAE bloom formation and low river flow (e.g., Paerl [1987]; Christian et al. [1986]). Given the tens of thousands of MSAE cells introduced to the lower-Klamath River from Copco and Iron Gate Reservoirs above, the potential for recurring blooms downstream increases as slower-moving water is encountered. For example, as described above, MSAE cell concentration exceeded 1.3 million cells/ml in a backwater area near the confluence of Coon Creek nearly 100 miles downstream from Iron Gate Dam.

Taken together these data provide compelling evidence that Copco and Iron Gate Reservoirs are providing ideal habitat for MSAE; increasing concentrations dramatically from those upstream, and exporting MSAE to the downstream environment.

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APPENDIX I. – PacifiCorp Submittal to FERC in Response to Agency Comments (including portion of Table 10 dealing with MSAE in the Klamath River).

825 N.E. Multnomah
Portland, Oregon 97232

PACIFICORP
PACIFIC POWER UTAH POWER

December 16, 2005

E-Filed 12/16/05

Ms. Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Klamath Hydroelectric Project (FERC Project No. 2082-027); Response to Agency Comments

Dear Ms. Salas:

With this letter and associated enclosures, PacifiCorp submits Response to Agency Comments in regard to the Klamath Hydroelectric Project (FERC Project No. 2082) as detailed below.

Response to Agency Comments

As requested by the Commission in the February 17, 2005 AIR, PacifiCorp asked several agencies and tribes to provide comments on documents we prepared in response to AIRs AR-1 (Anadromous Fish Protection), AR-2 (Anadromous Fish Restoration) and AR-5 (Instream Flow Studies). PacifiCorp has received several comment letters, and has prepared detailed response tables for these letters (attached). Tables 1 through 4 provide our comment responses to letters received on AIR AR-2 from the Oregon Department of Fish and Wildlife (ODFW), State Water Resource Control Board (SWRCB), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Game (CDFG). Tables 5 through 8 provide our comment responses to letters received on AIR AR-1 from SWRCB, CDFG, USFWS, and the National Marine Fisheries Service (NOAA-Fisheries). These tables are in addition to the AR-1 comment letter responses we previously submitted to the Commission on October 17, 2005. Table 9 provides comment responses to the letter received on AIR AR-5 from NOAA-Fisheries. This table is in addition to the AR-5 comment letter responses we previously submitted to the Commission on September 30, 2005.

•

On November 15, 2005, SWRCB submitted a letter to the Commission describing a study by the Karuk Tribe of California on 2002 nutrient and hydrologic loading to Iron Gate and Copco reservoirs. Table 10 provides PacifiCorp's responses to the November 15 SWRCB letter.

If you have any questions about this information, please contact me at (503) 813-6011.

Sincerely,

Cory Scott
Licensing Project Manager
PacifiCorp

cc: John Mudre - FERC
FERC Klamath Service List

Enclosures:

1) Response to Agency Comments:
   a. Table 1. Responses by PacifiCorp to comments from Oregon Department of Fish and Wildlife (Amy M. Stuart) (dated October 13, 2005) on PacifiCorp's draft report on Additional Information Request (AIR) GN-2 and AR-2, Anadromous Fish Restoration, Klamath Hydroelectric Project, FERC No. 2082.
   b. Table 2. Responses by PacifiCorp to comments from State Water Resources Control Board (via letter from Russ Kanz dated October 13, 2005) on PacifiCorp's draft report on Additional Information Request (AIR) AR-2, Anadromous Fish Restoration, Klamath Hydroelectric Project, FERC No. 2082.
   c. Table 3. Responses by PacifiCorp to comments from U.S. Fish and Wildlife Service (via letter from Phil Detrich dated October 17, 2005) on PacifiCorp's draft report on Additional Information Request (AIR) AR-2, Anadromous Fish Restoration and GN-2, Fish Passage Planning and Evaluation, Klamath Hydroelectric Project, FERC No. 2082.
   d. Table 4. Responses by PacifiCorp to comments from California Department of Fish and Game (Donald B. Koch) (dated October 31, 2005) on PacifiCorp's Response to Federal Energy Regulatory Commission (FERC) Additional Information Request (AIR) AR-2: Fish Passage Planning and Evaluation, Klamath Hydroelectric Project (Project) FERC No. 2082.
   e. Table 5. Responses by PacifiCorp to comments from the State Water Resources Control Board (via letter from Russ J. Kanz to Cory Scott of PacifiCorp dated October 20, 2005) on PacifiCorp's September 2005 submittal in response to Federal Energy Regulatory Commission (FERC) Additional Information Requests (AIR) AR-1 on anadromous fish protection, Klamath Hydroelectric Project, FERC No. 2082.
   f. Table 6. Responses by PacifiCorp to comments from the California Department of Fish and Game (via letter from Donald B. Koch to Cory Scott of PacifiCorp dated October 27, 2005) on PacifiCorp's September 2005 submittal in response to Federal Energy Regulatory Commission (FERC) Additional Information Requests

(AIR) AR-1 Part (a) and AR-1 Part (b) on anadromous fish protection, Klamath Hydroelectric Project, FERC No. 2082.

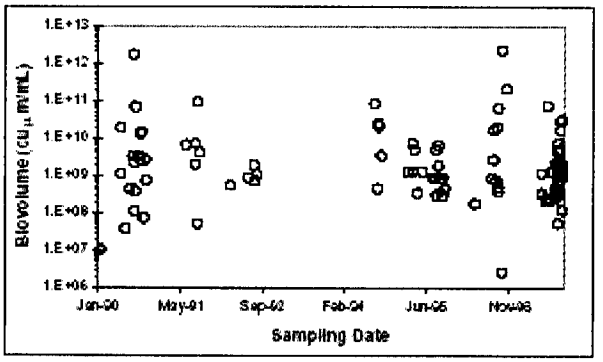
g. Table 7. Responses by PacifiCorp to comments from the U.S. Fish and Wildlife Service (via letter from Phil Detrich to Cory Scott of PacifiCorp dated November 17, 2005) on PacifiCorp's October 17, 2005 response to the U.S. Fish and Wildlife Service comments dated October 12, 2005 on PacifiCorp's September 2005 submittal in response to Federal Energy Regulatory Commission (FERC) Additional Information Requests (AIR) AR-1 Part (a) on anadromous fish protection, Klamath Hydroelectric Project, FERC No. 2082.

h. Table 8. Responses by PacifiCorp to comments from the NOAA-Fisheries (via letter from Steven A. Edmondson to Cory Scott of PacifiCorp dated November 23, 2005) on PacifiCorp's September 2005 submittal in response to Federal Energy Regulatory Commission (FERC) Additional Information Requests (AIR) AR-1 Part (a) and AR-1 Part (b) on anadromous fish protection, Klamath Hydroelectric Project, FERC No. 2082.

i. Table 9. Responses by PacifiCorp to comments from the NOAA-Fisheries (via letter from Steven A. Edmondson to Cory Scott of PacifiCorp dated October 3, 2005) on PacifiCorp's April 2005 submittal in response to Federal Energy Regulatory Commission (FERC) Additional Information Requests (AIR) AR-5 on instream flow studies report, Klamath Hydroelectric Project, FERC No. 2082.

j. Table 10. Responses by PacifiCorp to a letter from State Water Resources Control Board (from Russ Kanz dated November 15, 2005) to FERC on the subject of 2002 nutrient and hydrologic loading to Iron Gate and Copco reservoirs, Klamath Hydroelectric Project, FERC No. 2082.

Table 10. Responses by PacifiCorp to a letter from State Water Resources Control Board (from Russ Kann dated November 15, 2005) to FERC on the subject of 2002 nutrient and hydrologic loading to Iron Gate and Copco reservoirs, Klamath Hydroelectric Project, FERC No. 2082.

COMMENT	COMMENT RESPONSE
SPECIFIC COMMENT – Finally, enclosed are results of phytoplankton sampling conducted this year in Iron Gate and Copco Reservoirs, and in the Klamath River above Copco Reservoir and below Iron Gate Dam. This information is preliminary, but shows the high levels of Microcystic aeruginosa were found in Iron Gate and Copco Reservoirs this summer. In addition, the data shows that no Microcystis was found in the Klamath River above Copco Reservoir, while it was found in the river below Iron Gate Dam. Additional samples were collected in the river from Iron Gate Dam to the estuary by US Fish and Wildlife Service, Karuk Tribe and Yurok Tribe.	The suggestion in SWRCB's letter that no *Microcystis* or *Anabaena* algae were found in the Klamath River above Copco is inaccurate. *Microcystis aeruginosa* is ubiquitous in the Klamath River, and has been frequent and abundant in Upper Klamath Lake (Figure 1).  Figure 1. Occurrence of *Microcystis aeruginosa* in Upper Klamath Lake (Klamath Tribes data in Geiger 2005). *Microcystis aeruginosa* has been observed in samples from various locations, such as J. C. Boyle Reservoir, Keno reservoir the Klamath River below Boyle dam, the Klamath River above Shovel Creek, Copco reservoir, the Klamath River above Iron Gate reservoir, Iron Gate reservoir, the Klamath River below Iron Gate dam, and the Klamath River at I-5 (see phytoplankton data available at PacifiCorp's website).

Added Comment by Kann for this report.

Note: The graph above is a misrepresentation of Upper Klamath Lake MSAE data for several reasons:

1. The reported biovolume units in the Klamath Tribes phytoplankton database are in μm^3/**L**, not as μm^3/**mL** as shown above. Thus, the magnitudes shown in PacifiCorp's Table 10-Figure 1 are high by **3 orders of magnitude**, or 1000x.
2. The title for Figure 1 incorrectly states that the data shown are for Upper Klamath Lake; however, stations from Agency Lake are also included in the graph, and these stations constitute most of the higher values shown. See Figures 4a and 4b above showing that most of the biovolume values greater than $1x10^7$ are from Agency Lake (these correspond to the values greater than $1x10^{10}$ [1.E+10] in PacifiCorp's Figure 1).
3. None of the non-detects or zero values for MSAE are shown in Figure 1; this causes the graph to misrepresent the frequency of MSAE in the lakes. See Figure 4a above showing all measurements, including zero biovolume samples.

APPENDIX II. – Letter submitted to FERC by California State Water Resources Board—see red highlighted section of Klamath River MSAE.

State Water Resources Control Board

Division of Water Rights
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Alan C. Lloyd, Ph.D.
Agency Secretary

Arnold Schwarzenegger
Governor

November 15, 2005

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Dear Ms. Salas:

2002 NUTRIENT AND HYDROLOGIC LOADING TO IRON GATE AND COPCO RESERVOIRS, KLAMATH HYDROELECTRIC PROJECT, FERC #2082

The Karuk Tribe of California recently completed a study on the nutrient loading of Iron Gate and Copco Reservoirs. These reservoirs are part of the Klamath Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) #2082, which is owned and operated by PacifiCorp. The objectives of the study is to 1) compile existing nutrient and hydrologic data for Copco and Iron Gate Reservoirs, 2) construct mass-balance nutrient budgets to evaluate potential effects of the reservoirs on nutrient dynamics in the Klamath River, and 3) identify data gaps to help design future studies.

The study involves the construction of a nutrient budget combining nutrient concentration data with the hydrologic data to compute nutrient mass. The results show the reservoirs have periods during which they both trap and generate nutrients. The conclusion of the study is that "The more robust seasonal analysis presented here does not support an earlier PacifiCorp (2004a; 2005b) broad postulation that the reservoirs benefit water quality by processing organic matter and nutrients from upstream sources. With the given data set, there is a clear indication that the reservoirs periodically increase nutrient loading downstream. Likely pathways for this increased load include internal sediment loading and nitrogen fixation by cyanobacteria." The study can be downloaded at http://www.krisweb.com/ftp/KlamWQdatabase/Copco_IG_Budgets.zip. Because of the limitation of this study, and the importance of understanding how nutrients cycle through these reservoirs, State Water Resources Control Board (State Water Board) staff applied for, and received a grant from the US EPA to conduct a nutrient budget study of Iron Gate and Copco Reservoirs. The study should be completed in the summer of 2006.

Finally, enclosed are results of phytoplankton sampling conducted this year in Iron Gate and Copco Reservoirs, and in the Klamath River above Copco Reservoir and below Iron Gate Dam. This information is preliminary, but shows the high levels of *Microcystis aeruginosa* were found in Iron Gate and Copco Reservoirs this summer. In addition, the data shows that no *Microcystis* was found in the Klamath River above Copco Reservoir, while it was found in the river below Iron Gate Dam. Additional samples were collected in the river from Iron Gate Dam to the estuary by US Fish and Wildlife Service, Karuk Tribe, and Yurok Tribe.

If you have any questions about this letter or need additional information, please contact me at (916) 341-5341.

Sincerely,

ORIGINAL SIGNED BY

Russ J. Kanz
Staff Environmental Scientist

Enclosure

cc: Klamath Service List

bcc: Jim Kassel
Jim Canaday
Sharon Stohrer
Matt Myers
Beth Lawson
Dana Heinrich, OCC
Matt St. John, RB1
David Leland, RB1

RK:llv 11/14/05
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State Water Resources Control Board

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Terry Tamminen
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

April 22, 2004

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First Street, N. E.
Washington, DC 20426

Dear Ms. Salas:

APPLICATION FOR NEW LICENSE, KLAMATH HYDROELECTRIC PROJECT - FERC #2082

On March 1, 2004, we received a copy of the Application for New License (application) for the Klamath Hydroelectric Project (project), Federal Energy Regulatory Commission (FERC) Project #2082. The project is owned and operated by PacifiCorp. The FERC issued a Notice of Application Tendered for Filing, and solicited requests for additional studies, with a deadline of April 26, 2004. State Water Resources Control Board (SWRCB) staff and North Coast Regional Water Quality Control Board (NCRWQCB) staff reviewed the application for conformance with the requirements of title 18 of the Code of Federal Regulations, sections 16.8(c) and 4.51, and with the requirements for a complete application for water quality certification under section 401 of the Clean Water Act (401 certification). After reviewing the application we have identified additional studies/information that will be required for the SWRCB to make an affirmative decision on the completeness of an application for 401 certification. This letter notifies the FERC of the additional studies and/or information that the SWRCB will be requesting from PacifiCorp. See Cal. Code Regs. tit. 23, § 3835, 3856. Also included in this letter are general and specific comments on the application, information on California Environmental Quality Act (CEQA) compliance, and comments on the collaborative process.

Clean Water Act Section 401 Certification

Section 401 of the federal Clean Water Act (33 U.S.C. § 1341) (CWA) requires any applicant for a federal license or permit, which may result in any discharge to navigable waters, to obtain certification from the State that the discharge will comply with the applicable water quality parameters in the Act. In this case the federal agency issuing the license is the FERC. The sections of the CWA for which a state must certify compliance before issuing a section 401 certification include sections 301 and 302 (effluent limitations), section 303 (water quality standards and implementation plans), section 306 (national standards of performance for new sources), and section 307 (pretreatment effluent standards).

Under section 303 of the CWA and under the Porter-Cologne Water Quality Control Act, the NCRWQCB has adopted and the SWRCB and U.S. Environmental Protection Agency have approved the *Water Quality Control Plan for the North Coast Region* (1993) (Basin Plan) (North Coast Regional Water Quality Control Board, 1993). The Basin Plan designates the beneficial

uses of waters to be protected along with the water quality objectives necessary to protect those uses. The Basin Plan for the North Coast Region lists municipal and domestic supply, industrial service and process supply, ground water recharge, freshwater replenishment, hydropower generation, water contact recreation, non-contact water recreation, commercial and sport fishing, warm and cold fresh water habitat, wildlife habitat, migration, spawning, reproduction and/or early development, aquaculture, and rare, threatened and endangered species as beneficial uses of the Klamath River. The beneficial uses of the water at Copco and Iron Gate Reservoirs are listed as freshwater replenishment; hydropower generation; water contact recreation; non-contact water recreation; commercial and sport fishing; warm and cold freshwater habitat; wildlife habitat; migration, spawning, reproduction and/or early development; aquaculture; and rare, threatened or endangered species. The beneficial uses together with the water quality objectives that are contained in the Basin Plan constitute state water quality standards under section 303 of the CWA.

The water quality objectives set or describe the water quality limits necessary to achieve and protect the beneficial uses. PacifiCorp must evaluate the impacts of its project on the Klamath River and the waters stored within project reservoirs in order to determine whether the project complies with all applicable water quality objectives in the Basin Plan, and that the project does not impair the established beneficial uses of the Klamath River or the reservoirs. Of the various applicable water quality objectives, the most critical are dissolved oxygen, temperature, and nutrients. However, PacifiCorp should evaluate its project for compliance with all water quality objectives in the Basin Plan, as well as other applicable objectives and criteria, such as those included in the California Toxics Rule (CTR), the Department of Health Services' Maximum Contaminant Levels (MCLs), etc. If the project does not comply with one or more of the water quality objectives or criteria then PacifiCorp must describe the actions that it will take to bring its project into compliance with the applicable water quality limits in order to protect and maintain the beneficial uses. Please note that in cases where there are multiple criteria for the same constituent, the most stringent criterion applies.

As you know this Project operates in both California and Oregon. Accordingly, there is a potential that discharges from parts of the project that are located in Oregon may adversely affect the ability to meet the water quality standards in California. Two agencies must issue 401 certifications for this project, the Oregon Department of Environmental Quality (ODEQ) and the SWRCB. The SWRCB comments primarily will focus on the aspects of the project in California. However, we have requested studies in Oregon to determine the impacts to water quality in California. We have been working, and will continue to work, closely with the ODEQ on coordination of the Clean Water Act section 401certification issues for this project.

In the application PacifiCorp states it expects that water quality measures will be refined as consultation and coordination continues on the 401 certification process. The submission of the application, and subsequently the application for 401 certification, are critical steps in the "consultation" to obtain a 401 certification. SWRCB staff have been providing PacifiCorp guidance on the information that will be required to complete its application for 401

certification. While SWRCB staff will continue to assist PacifiCorp in completing its application for 401 certification, it must be diligent and committed to following the advice provided.

General Comments

The application fails to fully address all of the project impacts on water quality, specifically the beneficial uses of the Klamath River. Section 3.0 of Exhibit E provides a description of the water quality standards (beneficial uses, and water quality objectives), but does not describe the impacts of the project on water quality standards. Because a description of the impacts is not included in the application, PacifiCorp was unable to provide measures to avoid or mitigate project induced impacts. The application must disclose all of the water quality impacts and provide a list of measures to avoid or mitigate project induced impacts to water quality. Without this information the SWRCB will not be in a position to find that the application for 401 certification is complete [d1]or consider issuance of section 401 certification.

CEQA (Cal. Pub. Resources Code, § 21000 et. seq.) requires public agencies to consider the environmental impacts of their decisions to carry out or approve projects. It is the policy of the State of California to develop and maintain a high quality environment now and in the future, and take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state. It is also state policy to take all action necessary to provide the people of the state with clean water, and prevent the elimination of fish or wildlife species due to man's activities, and to insure that fish and wildlife populations do not fall below self perpetuating levels.

The project impacts of concern to SWRCB and NCRWQCB staff are those to water quality (specifically the cold freshwater habitat beneficial use) and fisheries (spawning, reproduction, and/or early development; migration of aquatic organisms; and rare, threatened or endangered species beneficial uses). The Klamath River once sustained large runs of steelhead and salmon, and is described as the third greatest salmon and steelhead river on the West coast, only behind the Sacramento River and Columbia Rivers. The Basin Plan, which the SWRCB and the NCRWQCB have the responsibility to implement, protects all of the anadromous fish in the Klamath River by designating beneficial uses (cold fresh water, spawning, reproduction, and/or early development; migration or aquatic organisms; and rare, threatened or endangered species beneficial uses). Modeling shows the project decreases water temperature in the spring/early summer and increases water temperature during the late summer/fall downstream of Iron Gate Dam. While the water quality is affected below Iron Gate Dam, project dams have inundated and blocked access to important historic salmonid spawning and rearing habitats. The cumulative effects of impaired water quality and reduction of critical habitat has resulted in significant impacts to anadromous fish. This is reflected by the National Oceanic and Atmospheric Administration (formerly National Marine Fisheries) listing of the Southern Oregon/Northern California coho salmon as a threatened species in 1991, the substantial decline in numbers of fall run Chinook salmon, steelhead, and the extirpation of spring run Chinook salmon from the Middle Klamath River. Anecdotal information indicates that the last spring run

Chinook salmon disappeared from the Middle Klamath River soon after the construction of Iron Gate Dam
(Mike Belchik, per. comm.). The key to stopping the decline of salmon is the removal of dams and/or the protection and/or restoration of their spawning streams (Moyle, 2002). Dam decommissioning therefore, must be an alternative fully evaluated as mitigation for the water quality impacts of this project. The section on additional studies and/or information below further addresses the issue of dam decommissioning.

The various sections of the application present observations, but in many cases fail to make linkages to other observations in other sections. This is not well integrated into an overall picture of impacts and ways in which PacifiCorp intends to minimize or prevent them.

Pre-project and "without project" (WOP) is couched in terms of existing conditions. This baseline makes it relatively easy to express conclusions of no project impact. At a minimum, the WOP alternative should assume a restored and functioning river. The WOP alternative is not consistently analyzed across all facets of the operation. For example, there is brief WOP discussion regarding water quality, but none regarding fisheries or recreation. PacifiCorp should analyze conditions and impacts for all facets of the project under a WOP scenario.

PacifiCorp (Toby Freeman) has stated repeatedly that it will not consider a full range of project alternatives (i.e. dam removal). The SWRCB has independent regulatory authority and responsibilities to condition the project to protect water quality and the beneficial uses of the affected lakes and stream reaches consistent with section 401 of the CWA. Any certification under section 401 by the SWRCB must be consistent with the standards in the Basin Plan[d2], SWRCB regulations regarding water quality certifications, CEQA, and any other applicable state law. Without adequate information on a range of alternatives for relicensing, the SWRCB will not be in a position to issue a section 401 certification.

Water quality in the Klamath River is controlled to a large extent by Upper Klamath Lake (UKL). UKL is a hypereutrophic lake due to large inputs of phosphorus rich spring water and phosphorus rich sediments from upstream natural and anthropogenic sources. Sediment sampling has shown that the species of diatoms and algae in UKL, along with water quality began to change concurrent with European settlement about 1850. Large nutrient inputs have resulted in massive blooms of cyanobacteria (*Aphanizomenon flos aquae*), which have caused significant water quality impacts (low dissolved oxygen, high pH, increased water temperature) resulting in large fish kills. Water quality conditions in UKL largely control water quality conditions in the lower river. However, studies show that the project also causes changes in water quality and impacts the beneficial uses of the Klamath River. Water quality is the dominant factor affecting most of the resources issues related to this project. The Klamath Basin is socially and politically complex with many parties competing over a finite resource provided by the Klamath River, water. It is important to understand the past, present, and future impacts of the project both within the FERC boundaries of the project, and on a basin wide scale.

SWRCB and NCRWQCB staff reviewed the application for consistency with the requirements in title 18 of the Code of Federal Regulations, sections 16.8(c) and 4.51. The application does not contain all of the information required by these sections. Because the application is not complete per the requirements of title 18 of the Code of Federal Regulations, sections 16.8(c) and 4.51, the application is deficient or patently deficient. 18 C.F.R. § 4.32 (e).

Specific Comments

Initial Statement

Page 10 – PacifiCorp holds a California appropriative water right (License 9457) for a maximum diversion of 1,800 cubic feet per second (cfs) through the power generators, 50 cfs through the fish propagation facilities and 3,300 cfs to refill the pondage or regulatory storage space in Iron Gate Reservoir. The total diversion shall not exceed 3,300 cfs. The application should recognize that the license for Iron Gate is subject to and subordinate to water rights for the diversion of water from the Klamath River for use in the Shasta Valley-Ager area for higher uses, up to an annual quantity of 220,000 acre feet, under certain conditions. The State of California also holds a senior water right for 60,000 acre feet of water, stored in Iron Gate Reservoir, for the purpose of generating power at Iron Gate Dam. The State of California holds a second senior water right for 60,000 acre feet of water stored in Iron Gate Reservoir, for the purposes of irrigation, industrial, domestic, municipal, recreation, and fish and wildlife uses in the Shasta Valley.

PacifiCorp claims two pre-1914 water rights for the Fall Creek Powerhouse. In 1985 the turbines and supply valves were replaced, and in 1988 the canal was upgraded. PacifiCorp must explain if there was a change in capacity of the canal or generator in 1985 or 1988. Any increase in the amount of water diverted from Fall Creek that is not authorized under a pre-1914 or other valid water right would require a new water right permit. SWRCB staff will also request that PacifiCorp submit generation records from before and after 1988 to document if there was a change in generation.

Executive Summary

Page 3-7 – PacifiCorp is proposing to exclude the Keno Development (Dam and Reservoir) from any new FERC license that may be issued. The decision to allow removal of this development from the project license will be determined by the FERC. PacifiCorp must study the impacts of the development, and propose Protection, Mitigation, and Enhancement (PM&E) measures for the project until such time as the FERC approves removal of the development from the new license. Keno Reservoir creates significant water quality impacts, both in the reservoir and downstream in the Klamath River. PacifiCorp must disclose all of the water quality impacts and provide a list of measures to avoid or mitigate project induced impacts to water quality.

Page 3-8 – PacifiCorp states that "The reservoirs are more effective than the Klamath River in retaining organic matter, especially particulate forms, and nutrients delivered from the Upper Klamath Lake and the Klamath Irrigation Project. Retention of organic matter and nutrients in the reservoirs results in periodic seasonal blooms of planktonic algae and contributes to low

dissolved oxygen below the thermocline. This results in a net decrease in organic matter and nutrients that otherwise would continue downstream and contribute to increased algae growth in the Lower Klamath River." The assumption that the reservoirs trap nutrients at a greater rate than the river would in a restored (without project) condition is repeated throughout the application. The application does not provide substantial evidence to support this conclusion, and may in fact provide information that does not support the assumption. The water quality model prepared by Watercourse Engineering uses the CE QUAL W2 model for reservoirs, and the RMA 11 and RMA 2 models for the river reaches. For the WOP scenarios, reservoir bathymetry was used to develop river geometry, and the CE QUAL W2 (reservoir) sections of the model were converted to RMA 11 and 2. This conversion is poorly documented in Appendix 4A of the Water Resources DTR, Klamath River Modeling Framework. Under the WOP scenario at about river mile 185-190 there is a sudden and extreme diel fluctuation in dissolved oxygen (DO) (Figure 4.8-70, Water Resources DTR). This is attributed to the algal dynamics in the middle Klamath River in the vicinity of, and below, Iron Gate Dam. Transport of organic matter and nutrients under WOP takes 2 to 3 days from Link River, compared with 6 to 8 weeks in the existing condition (EC). PacifiCorp therefore assumes that under the EC extended transit times allow sufficient time for nutrient retention and particulate matter to settle in the reservoirs.

SWRCB and NCRWQCB staff have discussed this issue at length and cannot concur with the conclusion that reservoirs are trapping nutrients at a greater rate than the river in a WOP condition. The following comments will clarify the basis of this conclusion:

- When the water quality model was converted from the EC to the WOP condition, the model assumed the river continued to function in its current (degraded) condition. Under a true WOP condition, the river's assimilative capacity would increase with the increase in quality and quantity of periphyton and riparian function. Watercourse Engineering conducted some attached algae surveys last year, and additional surveys will be conducted this year (see additional information request below). The algae studies may show differences in attached algae between the peaking reach and the river below Iron Gate Dam that may inform assumptions used in the model. The large diel swing in DO at river mile 185-190 appears to be an artifact of the model. It is abnormal for a river to experience a sudden large swing in DO at a specific location. SWRCB staff believe that changing model assumptions about primary production may provide a much different conclusion. Some sensitivity analysis of the model may also be needed to understand which factors are driving model SWRCB staff will request that additional model runs be made with different assumptions (see additional information request below).

- Beginning in 1996 the United States Geological Survey (USGS) conducted a water quality study of the Klamath River at the request of the Klamath River Basin Fisheries Task Force and the U.S. Fish and Wildlife Service (Campbell, 1999). The objective of the report was to characterize water quality as it affects anadromous fish production. The conclusion of the report was that both total and ortho-phosphorus concentrations had a tendency to increase in a downstream direction from Keno to Iron Gate. Ammonia,

total Kjeldahl nitrogen, total nitrogen and total organic nitrogen concentrations exhibited a strong tendency to decrease in a downstream direction. Nitrate concentrations tended to increase in a downstream direction. The conclusion of the report was that "the reservoirs–in-series do not seem to be functioning as a significant nutrient sink between the Keno, OR and Iron Gate Dam, CA locations. . . . "

- Recent monitoring by USGS further supports the findings by Campbell (1999). USGS conducted water quality monitoring in the Klamath River in July, August, and September 2002, and calculated loading rates based on the monitoring results. With the exception of ammonia plus organic-Nitrogen and pheophytin-a loads in September 2002, nutrient and organic material loads (including ammonia-Nitrogen, ammonia plus organic-Nitrogen, ortho-Phosphorus, total Phosphorus, chlorophyll-a, and pheophytin-a) all increase in the months July, August, and September 2002 from the monitoring station located on the Klamath River below Shovel Creek (located upstream of Copco Lake) to a monitoring station located below Iron Gate Dam (USGS, 2004). This same comparison is not possible for 2003, as USGS did not monitor stations upstream of Iron Gate Dam.

- The application includes a report by Eilers and Gubala on sediment samples from all of the project reservoirs. The sediment samples in the reservoirs were reported to have lower water content than those in Upper Klamath Lake, which is an indicator of a higher proportion of inorganic material. The carbon, nitrogen, and phosphorus content of the samples was also measured. The carbon content of the samples was highest in Lake Ewanuna, and consistently low in J.C. Boyle, Copco, and Iron Gate Reservoirs. The low carbon content, along with the low water content, would indicate that these impoundments are not accumulating organic matter and associated nutrients. Further, on a percentage basis the ratio of carbon to nitrogen (C:N) of Project reservoir sediments are almost twice as great as that expected for phytoplankton (FTR Page 6-43). This may indicate that, on a percentage basis, phytoplankton are not a major component of the sediments.

- At the end of October 2003, Joe Eilers (Eilers, 2004) was conducting hydro acoustic testing to locate fish in Copco Reservoir. While on the reservoir, a low-pressure system developed, and wind increased. He observed a massive release of gasses from the bottom of the reservoir that turned the surface of the reservoir to foam. This large release of gasses could have pushed accumulated nutrients into suspension, and facilitated their transport out of the reservoir. While the reservoirs may trap some nutrients and organic matter during the summer period of high phytoplankton activity, the accumulated materials may become suspended and flushed from the reservoirs during fall turnover. In Exhibit E, page 3-108 there is a statement that "Extended periods of anoxia promote conditions that result in the reduction of NO_3 to NH_4 and can lower the ORP to the point that phosphorus is released from the sediment." Such conditions occur regularly in Copco Reservoir. Under this condition phosphorus and ammonia would be held in suspension and readily dispersed during reservoir turnover. Additional monitoring would

confirm the transport of high concentrations of nutrients from the reservoirs after fall turnover.

- To determine the nutrient trapping capacity of the reservoirs, additional core samples should be collected and analyzed to quantify the nutrient content of sediments. This should provide verification of the assumption that the reservoirs are trapping nutrients at a greater rate than the river.

Page 3-8 – Modeling shows that the project decreases water temperature below Iron Gate Dam in the spring and early summer, and increases water temperature in the late summer and fall. The decrease in water temperature in the spring/early summer may cause a retardation of juvenile salmonid development. Increase in temperature in the late summer/fall may impact returning adult fall run Chinook, Chinook egg incubation, and other species present in the river. Additional modeling has shown that cold hypolimnetic water from Iron Gate Reservoir could reduce water temperature for about a six-week period. The dissolved oxygen (DO) level in the hypolimnion of Iron Gate Dam is very low, which may require water to be oxygenated prior to release. Hypolimnetic water in Iron Gate Reservoir is also high in ammonia, and possibly methane and/or other constituents, which may be detrimental to downstream fisheries. Depletion of the cold water supply in the reservoir could result in significant impacts to the operation of the Iron Gate Hatchery that is dependant on the cold hypolymnetic water in the reservoir. PacifiCorp concludes that the low-level release of cool water for temperature management downstream of Iron Gate Dam is limited and may not be practicable (Exhibit E, page 3-211). PacifiCorp has only explored one option to mitigate for the impacts to water temperature below Iron Gate Dam. A full range of options to control water temperature must be evaluated. PacifiCorp must explain how it will mitigate for impacts caused by the alteration of water temperature below Iron Gate Dam. A request for additional study and information related to this issue is listed below.

Page 4-4 – PacifiCorp makes the statement that "Water quality in the Klamath River likely limits all runs of andromous fish at some point in their lifecycle, especially during the summer." PacifiCorp should identify and explain what water quality issues limit anadromous fish. It must also explain the impact of its project on the water quality and anadromous fish in the Klamath River. Once the water quality impacts are identified, PacifiCorp must provide measures to avoid or mitigate for the impacts.

Page 4-10 – The conclusion is there is no impact to trout spawning/incubation/emergence, because no trout spawning occurs in the peaking reach, because there is not any gravel. However, the geomorphology study recognized that gravel is not found in the project bypass and peaking areas because of scouring flows. That is a project impact and should be recognized as such. PacifiCorp is proposing to augment gravel in the river below J.C. Boyle and Iron Gate Dams. Monitoring will be required to determine if this action will provide adequate mitigation for the loss of spawning gravel.

Exhibit E 3.0

Page 3-19 – It is important to understand that PacifiCorp and the Bureau of Reclamation (BOR) coordinate flows at Link River, flows through the East and West Side Powerhouses, and flows in and out of Keno Reservoir to provide stable flows below Keno Dam. The WOP scenario shows wide daily/weekly fluctuations in flow, which may not occur, in a real WOP situation. The BOR may be under some obligation to regulate flows in the Klamath River below Keno Dam. If the FERC approves removal of Keno from any license that may be issued, the FERC should consider whether PacifiCorp can and should be required to operate the dam to provide flow stability downstream.

Pages 3-44 & 45 – The information on water rights is incorrect. The correct information on water rights is on page 10 of the Initial Statement.

Page 3-129 – PacifiCorp states that "it is unlikely that the J.C. Boyle peaking reach supports broadly distributed populations of large unionid bivalves." PacifiCorp attributes this condition to the high gradient nature of the reach. Data should be submitted to support this conclusion. Other factors are also likely to contribute to the lack of mussel diversity in this reach, including the effects of the peaking operations, and the exclusion of appropriate host species.

Section E3.5 - This section contains a description of the water quality conditions in the project "in the context of applicable water quality standards or objectives." There is a section for each of the water quality objectives listed in the Basin Plan. Each of these sections describes, in general terms, the water quality conditions, and lists the water quality objective. The summary data are not sufficient to determine if the PacifiCorp analysis is adequate (e.g., monthly or annual averages will dampen the impact of episodic releases). This section, and the entire application, fails to describe the project impacts on each of the water quality objectives. In California, the water quality standards consist of the beneficial uses, and the water quality objectives necessary for the protection of the beneficial uses. The objectives are either narrative or numeric. Once compliance with the objective is evaluated, there must be an analysis of the impact to the designated beneficial uses in the Basin Plan. The application fails to address impacts to beneficial uses.

Page 3-132 – The potential beneficial use of Aquaculture is missing from the list.

Page 3-133 – The Klamath River is designated as a Cold Interstate River, and as such, the temperature water quality objective is "Elevated temperature waste discharges into cold interstate waters are prohibited." This is a stricter standard than the standard shown in the application, which is for cold intrastate rivers. Additionally, the Basin Plan contains the following objective: "At no time or place shall the temperature of any COLD water be increased by more than 5° F above natural receiving water temperature." The stricter standard applies when two standards are shown.

Page 3-145 – The statement that California identifies the Klamath River as warm water, cold water, and wild trout habitat needs to be clarified. The Basin Plan identifies the Klamath River

as warm and cold freshwater habitat. The "wild trout habitat" designation is incorrect with regard to the Basin Plan. The "WILD" designation in the Basin Plan is for uses of water that support terrestrial ecosystems, including preservation and enhancement of terrestrial habitats, vegetation, wildlife, and wildlife water and food sources. The California Department of Fish and Game has designated the Klamath River from state line to Copco Reservoir as a wild trout reach with special regulations. Further, the Klamath River is on the CWA section 303(d) List for nutrients, temperature, and low dissolved oxygen all the way to the mouth, not just to the Scott River.

Page 3-145 – PacifiCorp erroneously compared the temperature at Link River to Iron Gate. It implies that under natural conditions (i.e., presumably without the project) the temperatures at Iron Gate would be the same or follow the same pattern as the temperature at Link River. This ignores the spring accretions and the input from Jenny Creek and Fall Creek, which might be significant in summer flows in the natural state. These inputs would not be represented in the pattern seen at Link River. The comparison should be to natural receiving water temperatures as called for in the Basin Plan, not to an upstream location.

Page 3-146 – When comparing the existing condition to a modeled WOP scenario, the river below Iron Gate Dam is warmer in the fall. This section of the application does not acknowledge that the same modeling shows the river is also cooler in the spring/early summer. As discussed above, both the cooling and warming of waters may have an impact on the beneficial uses of the river.

Page 3-146 -- Figure E3.5-7 uses daily average temperature. The text should discuss or reference a discussion as to the biological significance and relevance of this metric, and why this metric was chosen over other metrics for presentation of these results.

Page 3-148 – The water quality objective for dissolved oxygen (DO) in the Klamath River below Iron Gate Dam is a minimum of 8 mg/l with 50% or more of the monthly means greater than or equal to the lower limit 10 mg/l. The Karuk Tribe has conducted water quality monitoring in the Klamath River for several years (Karuk Tribe of California, 2003). They have established an objective of 6.0 mg/l for cold waters and a minimum of 9.0 mg/l during spawning and egg incubation. In 2002 they recorded 63 days for violation of the cold-water objective, and 213 days for violations for the spawning objective. Their data showed a maximum DO of 5.9 mg/l and a minimum of 1.9 mg/l on August 28, 2002. Their data shows pronounced episodic depressions in DO. PacifiCorp did not identify these events in the application. There is a discussion about a seiche, or wave, (Water Resources FTR, page 3-44) in the stratification that occurs in both Copco and Iron Gate Reservoir that may be responsible for these low DO events. PacifiCorp must explain these low DO measurements below Iron Gate Dam.

Page 3-154. The text suggests that changes in nutrient concentrations correspond to changes in Klamath Project diversions. If the document is asserting a causal link, the rationale for the link needs to be presented and discussed.

Page 3-151 – PacifiCorp attributes pH exceedances to photosynthetic activity because of the timing of the exceedances (March through November) and because their occurrence with high chlorophyll-a levels. PacifiCorp states that this is "a natural consequence of the high nutrient concentration of the waters entering the proposed Project area." PacifiCorp does not analyze the impacts of the reservoirs on nutrient cycling. The reservoirs are not a natural part of the river system. PacifiCorp also should discuss the potential for modifying photosynthetic activity, and photosynthetically induced pH changes, through operational changes or dam removal. PacifiCorp should compare the pH levels in the project segments to natural receiving water.

PacifiCorp states that "The Project does not cause or enable transformations in forms of nitrogen that could contribute to excess production in the Klamath River below the Project area." PacifiCorp dismisses the influence of the reservoirs on the biotic community that can fix atmospheric nitrogen or can change the forms of available nitrogen. The forms of nitrogen, not only the total concentration, are significant. PacifiCorp should analyze these data on a mass-loading basis, instead of just concentration. PacifiCorp should describe the nutrient cycling (seasonally and over time) in the reservoirs on a mass basis as well as concentration basis.

Page 3-162 –PacifiCorp appears to assert that the reservoirs play no role in the aesthetic conditions – the offensive algal blooms and associated odors. PacifiCorp attributes the conditions to agriculture and other upstream sources ignoring the role that the reservoirs play in establishing conditions for the overgrowth of algae. PacifiCorp also implies that, if not for the recreation opportunities offered by the reservoirs, no one would be offended because the conditions would not be noticed. SWRCB staff are concerned that PacifiCorp does not understand their contribution, or obligations to protect water quality. The designated beneficial uses for the reservoirs must be protected.

E 3-167 – PacifiCorp discusses only the California antidegradation policy. The federal antidegradation policy also applies and should be discussed. This is important because the two policies are different in some respects. For example, the federal policy applies to all waters of the U.S. regardless of the quality, whereas the state policy applies only to high quality waters. The federal policy applies only to existing beneficial uses, whereas the state policy applies to both existing and potential beneficial uses.

Page 3-196 – PacifiCorp is proposing to increase the minimum instream flow release and alter peaking operations at J.C. Boyle. A minimum of 200 cfs plus the J.C. Boyle Bypass Reach accretion will be provided at the USGS gauge downstream of the powerhouse. In addition, peaking operations will not exceed a 1,400 cfs maximum change in a 24- hour period. PacifiCorp is making this change to provide flow stability for aquatic resources while continuing to provide a balance of whitewater boating and angling opportunities. The change in peaking may provide only very small benefits to the aquatic system, and it is not clear how the change will effect whitewater boating and angling opportunities. A 1400 cfs rate of change is still a very extreme peaking event that will have significant impacts. On September 23, 1959, the Federal

Power Commission (FPC) issued a decision on the application for amendment of license by the California Oregon Power Company to construct Iron Gate Dam. The decision was based on the impacts caused by fluctuations in flow between 200 and 3300 cfs on a daily basis below Copco #2 powerhouse. These flow fluctuations were having a significant impact on navigation and fisheries in the river and "The evidence shows that fluctuating water levels such as this have a decidedly detrimental effect on fish and aquatic life."

It is not clear from the information supplied in the application how this change in operation compares to past operations. A number of years should be modeled comparing actual hydrographs with the new proposed peaking schedule. PacifiCorp must provide hydrographs that show the impact of the change in peaking operations on whitewater boating and angling. PacifiCorp should fully evaluate the impacts on boating and angling opportunities and provide appropriate methods to avoid, minimize, or mitigate for any impacts. It is also stated the change in peaking operation will improve water quality conditions, including decreasing the reach's unproductive varial zone (i.e. the area that becomes watered and dewatered on a daily basis due to peaking flows). These statements should be supported and quantified.

PacifiCorp states that the river below Iron Gate will be operated as run-of-the-river as directed by the BOR Operations Plan. PacifiCorp states that "Any additional increases in discharges from Iron Gate would require additional flow from upstream of the Project." This statement is not correct. During the fish kill in 2001 PacifiCorp released stored water from project reservoirs to help avert flow-related passage problems. PacifiCorp should explain the amount of regulatory storage available for use downstream, consistent with its water rights.

Page 3-213 – The timing of maintenance activities can impact the ability to respond to an ensuing fish die-off. Last summer, during a critical period of upstream salmonid migration, the reservoirs were drawn down and any additional flow that might have been needed to avert a passage-related die-off would have had to come from upstream of Copco Reservoir. PacifiCorp should include a provision that it would not draw down Iron Gate or Copco reservoirs during critical times when additional flow might be needed downstream during a fish die-off emergency.

Section E 3.9 – This section provides a brief discussion of the continuing impact of the project on water use and quality. PacifiCorp states that the project will continue to have effects on water quality, but again repeats the assumption that the reservoirs are more effective than the river at trapping organic matter and nutrients from UKL and the Klamath Irrigation Project. As stated above, SWRCB staff do not agree with the assumption that reservoirs provide enhanced water quality benefits to the river.

Exhibit E 4.0

Page 4-5, Table E4.1-2 - To our knowledge delta smelt do not occur in the Klamath River (Moyle, 2002).

Page 4-13 - The application concludes that there is little or no spawning habitat for trout in the peaking reach, and the amount of spawning gravel is limited because of J.C. Boyle Dam. The Salt Caves Project Application is cited as a reference for these conclusions. The Salt Caves Project Application states that the largest potential spawning area for trout is located near river mile 214. Because peaking operations start when trout eggs are in the gravel, they would become desiccated (City of Klamath Falls, November 1986) from the reduction in daily peaking flow magnitude and duration.

Page 4-14 – On September 23, 1959, the Federal Power Commission (FPC) issued a decision on the application for amendment of license by the California Oregon Power Company to construct Iron Gate Dam. The California Department of Fish and Game provided testimony that the Iron Gate Development would prevent access by salmon and steelhead trout to about 16 miles of spawning gravel and would also destroy one the of the most popular stream fishing areas in the upper Klamath River. As part of the amendment the Federal Power Commission required the California Oregon Power Company to build fish trapping, egg taking, and hatchery facilities. The Supreme Court later settled the disagreement over the cost to operate the hatchery.

Page 4-66 – Despite the hard work on instream flow issues by the relicensing collaborative, a number of tasks are left to be completed. These are listed in the application. One component of the study plan not listed as outstanding is completion of 2-D modeling agreed to by the Aquatic Working Group. It is important that the collaborative reach agreement on the Study Plan 1.12, Instream Flow Analysis Study Plan. This information is needed to determine the impacts of the project on the beneficial uses of the project-affected streams. PacifiCorp must complete a thorough assessment of instream flow needs for redband trout, other native resident species, and potentially anadromous species including salmon and steelhead.

Page 4-83 – Typical peaking operations at J.C. Boyle result in a streambed varial zone of about 30 feet with a river stage change of 20 inches in a period of 3 to 6 hours. Despite the admission that small fish would likely be affected by this peaking operation, the analysis of this impact is deficient in information to evaluate the validity of the study, namely are there sufficient numbers of juvenile fish in the peaking zone to observe stranding if it occurs? The Federal Power Commission acknowledged in 1959 that "evidence shows that fluctuating water levels such as this have a decidedly detrimental effect on fish and aquatic life." Flow fluctuations of this magnitude can also have a significant impact on attached algae. Studies on the Pit River (Spring Rivers Ecological Sciences, 2003) showed that flow fluctuations of a similar magnitude reduced attached algae covering 100 percent of the bed to an average of 0.6 percent coverage after the high flow event.

Page 4-92 – Studies have shown there is a difference in redband trout growth rates between the J.C. Boyle Peaking Reach and the Keno Reach. Figure E4.2-19 demonstrates that trout grow faster in the peaking reach until age two to three. After this age there are less age 3-5 trout in the peaking reach. Clearly the trout growth is being affected in the peaking reach. Craig Addley has completed a bioenergetics model for the project. The density and size of macroinvertebrates

was low in drift samples collected in the peaking reach. Drift samples in the peaking reach contained 0.1 prey/cubic foot, compared to 0.8 prey/cubic foot in samples from the river below Iron Gate (Addley, Per. comm.). There were eight times as many prey available below Iron Gate compared with the peaking reach. Preliminary modeling showed that conditions limit the growth of fish over 400 mm. This is consistent with the age/length data that was collected in the peaking reach. Additional drift sampling in the Keno Reach would help explain the differences in fish growth between the two reaches.

In the application, PacifiCorp concludes that spawning is not known to occur in the peaking reach because of the lack of suitable sized spawning gravel. Based on this information the conclusion is the peaking operation does not affect any known trout spawning areas. The Salt Caves Project Application states that the largest potential spawning area for trout is located near river mile 214 in the peaking reach. Because peaking operations start when trout eggs are in the gravel, they would become desiccated (City of Klamath Falls, November 1986) from the reduction in daily peaking flow magnitude and duration. The peaking operation may have over time reduced or eliminated trout that spawned in the main stem. Changes in geomorphology caused by the project may have also contributed to a reduction of spawning gravel. PacifiCorp must provide justification that the project does not impact the spawning ability of trout in the Klamath River.

Section E4.3 – Without question there has been a long-term significant decline in numbers of anadromous fish in the Klamath River over the last century. The project has contributed to this decline. Since construction of Iron Gate Dam in 1960, coho salmon have been listed under the Endangered Species Act, and four other anadromous species are under review for listing.

Anadromous fish are affected by this project in two ways. First, project dams and reservoir inundation have eliminated access to important historical main stem and tributary spawning and rearing habitats. Second, the project alters water quality downstream of Iron Gate Dam potentially affecting the migration, spawning and rearing of anadromous species. PacifiCorp fails to address the impacts of the project on the designated beneficial uses of spawning, reproduction, and/or early development; migration of aquatic organisms; and rare, threatened or endangered species.

To evaluate the impacts of this project on these beneficial uses requires a consideration of the historical, or natural background conditions, in the watershed. Water quality modeling and EDT modeling are providing some of the information on background conditions. However, PacifiCorp should also provide historical information on the anadromous fish runs (numbers) in the Klamath River. A collaborative subgroup was formed to help with the development of the EDT model. The EDT model requires the input of 46 habitat parameters. Because data were not available on all parameters in all reaches many assumptions were made. PacifiCorp must continue to work with the collaborative to reach agreement on the parameters used in the model. PacifiCorp must work with SWRCB staff to ensure that we agree with the parameterization of the model. Because of the large number of assumptions needed for a project of this size, it will

be important to have a peer review of the model. Sensitivity analysis may be needed to understand which habitat parameters are driving the model output. SWRCB staff will not be able to use the EDT model without consensus of a large number of stakeholders, and a high degree of confidence in the function of the model.

SWRCB staff are concerned that PacifiCorp has made preliminary EDT runs without stakeholder input, and without documentation of the inputs in the model. The model shows that even with high reservoir survival self-sustaining runs of Chinook salmon could not be achieved. SWRCB staff believe this run may be showing the level of impact the project has on Chinook salmon.

Page 4-126 - Iron Gate Hatchery was developed as mitigation for the loss of 16 miles of anadromous fish habitat from the construction of Iron Gate Dam. While the hatchery does provide for the production of fall run Chinook salmon, coho salmon, and steelhead, it has not mitigated for the project impacts to spring run Chinook. In addition, the hatchery may cause secondary impacts to the Klamath River fisheries, including residualism in steelhead, and genetic impacts to wild strains. The hatchery may also be causing water quality impacts to the river from its effluent. PacifiCorp must explain all of the impacts resulting from the operation of the hatchery.

Exhibit E 7.0

SWRCB staff must ensure the Basin Plan beneficial uses of water contact, non-water contact, and sport fishing are protected. Altered flow regimes with different timing or less variation would alter the frequency and quality of boating and fishing opportunities (Recreation Resources FTR, Page 2-117). PacifiCorp is proposing to increase the minimum instream flow release and alter peaking operations at J.C. Boyle. A minimum of 200 cfs plus the J.C. Boyle Bypass Reach accretion will be provided at the USGS gauge downstream of the powerhouse. In addition, peaking operations will not exceed a 1,400 cfs maximum change in a 24- hour period. This change is made to provide flow stability for aquatic resources while continuing to provide a balance of whitewater boating and angling opportunities. Currently whitewater boating and fishing opportunities are provided at "near optimal" (Exhibit E, page 7-115) levels on most days. However, PacifiCorp also states "Altered flow regimes with different timing or reduced variation due to peaking would alter the frequency and quality of these existing opportunities." Future management is tied to understanding the impacts and trade-offs between whitewater boating and fishing. As such PacifiCorp must explain the impact of the project on the beneficial use. PacifiCorp should fully evaluate the impacts on boating and angling opportunities and provide appropriate methods to avoid, minimize, or mitigate for any impacts.

Exhibit E 9.0

The National Environmental Policy Act (NEPA) requires a discussion of socioeconomic effects in an Environmental Impact Study. PacifiCorp states that ongoing operations of Iron Gate Hatchery are considered a PM&E (page 9-45 of Exhibit E). Additional detail on socioeconomic values are presented in the Socioeconomic FTR. However, the hatchery was a required mitigation and cannot be considered a benefit. Instead it is a partial offset for the fishery values

lost when Iron Gate Dam was constructed. The baseline under NEPA is existing conditions, which includes the operation of the hatchery. PacifiCorp has been consistent in following the NEPA baseline for all of the studies. It is not clear why PacifiCorp now consider the hatchery to be a PM&E.

The FERC requires inclusion of the socioeconomic impacts of a project with estimates for changes in employment or income associated with any anticipated modifications to recreation use in the project area, such as whitewater rafting, boating, or fishing. PacifiCorp has provided information on the replacement power value of this project. The California Energy Commission will be providing detailed comments on these estimates. However, PacifiCorp has not provided information on the value of other important resources being affected by the project.[d3] PacifiCorp should provide information on a range of alternatives, the costs and benefits of the alternatives, and the power and non-power values of the project. PacifiCorp must provide the socioeconomics for a full range of alternatives for the project. This includes the value of the salmon and steelhead fishery in a without project scenario and the cost of decommissioning the project.

Status of Study Plans and Additional Studies/Information Required

The FERC has requested that agencies submit additional study requests that should be conducted by PacifiCorp. Below is a list of additional studies and/or information that is necessary for inclusion in a complete application for 401 certification. The SWRCB will be notifying PacifiCorp that the studies and/or information listed below will be required for a complete application for 401 certification. SWRCB staff also recommend that the FERC include these studies in the Additional Information Requests to PacifiCorp. This list of study/information requests listed below should not be construed as the only ones required to complete the application for 401 certification. Due to the number of alternatives that must be evaluated, and because many studies have not been completed, the SWRCB may request additional information and/or studies at a later date.

The application states that nine study plans were not approved by the collaborative and are outstanding. These study plans are:

- Study Plan 1.7: Evaluation of Ramping Effects on Fish Downstream of Link Dam, Keno Dam, J.C. Boyle Dam, J.C. Boyle Powerhouse, Copco No. 2 Dam, and Iron Gate Dam.
- Study Plan 1.9: Fisheries Investigations.
- Study Plan 1.10: Fish Passage Planning and Evaluation.
- Study Plan 1.12: Instream Flow Analysis Study Plan.
- Study Plan 1.16: Evaluation of Effects of Flow Fluctuations on Aquatic Resources within the J.C. Boyle Peaking Reach.
- Study Plan 1.17: Investigation of Trout and Anadromous Fish Genetics in the Klamath Hydroelectric Project Area.
- Study Plan 1.18: Description of Migratory Behavior of Juvenile Salmon Smolts and Estimation of Success through Reservoirs using Radio-Telemetry Techniques in the Klamath Basin, 2004- Initial Study.

- Study Plan 1.23: Sampling of Fisheries in Project Riverine and Reservoir Areas.
- Study Plan 7.2: High Level Socioeconomic Analysis of the Landscape Options – Phase 2.
- Study Plan 7.3: Analysis of Effects of Differences Between the Proposed Project and the Current Project on the Socioeconomic Environment – Phase 3.

While certain collaborative sub-groups continue to work on some of these study plans, no assurances are provided that the collaborative will approve these study plans. PacifiCorp should provide assurance it will continue working with the collaborative to reach agreement on all of these study plans. PacifiCorp also will be required to complete these study plans to the satisfaction of SWRCB staff. Failure to do this may result in unnecessary delays in the relicensing process.

Entrainment

The Characterization of Resident Fish Entrainment and Turbine-Induced Mortality study has been in dispute for some time. Information on fish entrainment will be necessary to analyze project impacts on beneficial uses. We do not expect that literature alone will provide adequate information on the number of fish being entrained at project facilities, and that some site specific studies will be required. SWRCB staff consider sampling the tailrace of the powerhouse the only adequate method to quantify the level of entrainment, determine the species being entrained, and the level of turbine mortality. There is a seasonal element to entrainment that must be considered when designing a study.

Instream Flow

As stated in the application, a number of tasks needed to complete the instream flow study need to be completed. We recommend that the collaborative continue to meet and reach agreement on the following:

- Approve rainbow trout and sucker HSC curves
- Complete 2D analysis for peaking reach
- Develop a habitat time series
- Complete bioenergetics modeling efforts
- Conduct peaking analysis
- Discuss modeling results as they relate to fisheries and other interrelated studies (e.g., recreation, geomorphology, etc), and
- Develop river flow regime recommendations for aquatic resources

Information from the instream flow studies is essential for determining flows needed to support restoration and recovery of depressed populations of aquatic species that reside in the Klamath River and tributaries within the Project, including redband trout and ESA-listed suckers. Should there be a proposal to reintroduce salmon and steelhead to the Copco 2 Bypass Reach, or the J.C. Boyle Peaking reach, additional modeling to determine the appropriate flow for these species will be required.

Ecosystem Diagnosis and Treatment (EDT) and KlamRAS

A collaborative subgroup was formed to help with the development of the EDT model. The EDT model requires the input of 46 habitat measures. PacifiCorp must work with SWRCB staff to ensure that we agree with the parameterization of the model. Because of the large number of assumptions needed for a project of this size, it will be important to have a peer review of the model. For example, the model assumes that water temperatures over 21° C may cause severe mortality (Exhibit E, page 4-122). Additional data may be required to verify this assumption for the Klamath River. PacifiCorp should hold a workshop to explain all of the parameterization and assumptions used in the model, and explain model results. Sensitivity analysis may be needed to understand which habitat parameters are driving the model output. Where possible, the model should be validated against actual production in similar comparable rivers. KlamRAS is a stochastic life cycle model that will be used to understand the impacts of different fish passage options. KlamRAS uses habitat data (EDT) and fish passage survival to estimate fish production. It will be important to have some discussion and agreement on the input variables to this model.

Water Quality Data

PacifiCorp collected, or cooperated in collection of synoptic water quality data in the Klamath River and tributaries, and in the reservoirs (vertical profiles - grab and hydrolab). While the application contains summaries of water quality data collected throughout the project and below Iron Gate Dam, the raw data was not included. PacifiCorp should provide all of the raw water quality data to the SWRCB. Additional water quality data will need to be collected for DO and nutrients above and below Iron Gate Dam over a one-year period. The DO data is needed to determine compliance with the water quality objectives in the Basin Plan. The nutrient data is needed to determine the nutrient cycling in the reservoirs during fall turnover. SWRCB staff will expect PacifiCorp to prepare a study plan for the review and approval of the SWRCB that includes mass based nutrient cycling and flow through the project.

Numeric Water Quality Objectives

PacifiCorp has identified that its project alters water temperature in the Klamath River below Iron Gate Dam. SWRCB staff will request additional studies to fully evaluate the impact of this change in water temperature on the designated beneficial uses of the Klamath River.

When the Basin Plan lists narrative objectives, such as the one for temperature, the NCRWQCB or SWRCB must develop numeric objectives through literature review or site-specific studies. To determine the impact of PacifiCorp's project on the beneficial uses of the Klamath River, SWRCB staff requested that PacifiCorp complete a study to develop site specific numeric water quality objectives for Klamath River salmon, steelhead, and other species. SWRCB staff have requested (verbally and in a letter dated January 30, 2004) that PacifiCorp develop numeric water quality objectives for salmon and steelhead for the Klamath River. We expect PacifiCorp to develop a study plan that addresses this issue for SWRCB and NCRWQCB staff review and approval. During recent discussions, we agreed that PacifiCorp would review existing temperature studies and objectives that have been developed (including Oregon Department of

Environmental Quality and U.S. EPA) for salmon and steelhead and compile existing information on thermal refugia (Yurok Tribe and Bureau of Reclamation) from the Klamath River. Once this information is compiled PacifiCorp will develop proposed temperature objectives for review by SWRCB and NCRWQCB staff. After review of the information SWRCB staff will determine if the proposed objectives are adequate, or if addition information and/or studies are required.

State and Federal Agencies, and Tribal fisheries programs have been conducting surveys on outmigrating juvenile salmon and steelhead in the Klamath River and tributaries. PacifiCorp should compile this information, along with water temperature data, to determine the growth rates of juvenile salmon and steelhead in the main stem Klamath River versus the tributaries. This information will be used by SWRCB staff to determine the impact of reduced water temperature below Iron Gate Dam on growth of juvenile salmonids. In addition to the juvenile growth data, a bioenergetics model should also be developed to help evaluate the impacts of reduced water temperature on salmonid growth.

Water Temperature

As discussed above, the project alters water temperature in the Klamath River below Iron Gate Dam. PacifiCorp has conducted some modeling to evaluate utilization of the cool hypolimnetic water in Iron Gate Reservoir to provide cooling in the river downstream of the dam. PacifiCorp concludes that the low-level release of cool water for temperature management downstream of Iron Gate Dam is limited and may not be practicable (Exhibit E, page 3-211). PacifiCorp must explain how it will mitigate for impacts caused by the alteration of water temperature below Iron Gate Dam. The SWRCB will require PacifiCorp to study, evaluate, and submit to the SWRCB a full range of alternatives to reduce water temperature during the late summer/fall, and increase water temperature during the spring/early summer.

Dam Decommissioning

In our letter dated December 23, 2002, we requested that PacifiCorp develop a study plan consisting of a list of studies and engineering reports that would be necessary to decommission any of the project facilities (dams and powerhouses). At that time, studies showed that water quality impacts caused by the project could be mitigated through decommissioning. The requested study plan would have been used to direct the completion of the necessary studies and reports needed to decommission project facilities. PacifiCorp has not submitted the requested information to the SWRCB. Because the application has identified significant impacts from the operation of the project, dam decommissioning will be an alternative evaluated in the environmental document (see CEQA section below) prepared by the SWRCB as lead agency. PacifiCorp must submit the requested study to the SWRCB quickly. The SWRCB may request that additional studies be conducted to assist in the evaluation of the impacts of dam removal, or other alternatives that may be considered.

Reservoir Core Samples

The application cites a study by Eilers and Gubala (2003). Copies of the study must be submitted to the SWRCB and NCRWQCB. Additional core samples should be taken to assist in determining if the reservoirs are trapping nutrients and organic material. These core samples must also be analyzed for metals and toxic materials. This information will be used to determine the impacts of dam removal alternatives.

Water Quality Model

As discussed above, SWRCB staff have concerns about the WOP assumptions used in the water quality modeling. PacifiCorp should submit improved documentation on the assumptions used to develop WOP conditions in the model. Additional model runs will also need to be completed after SWRCB and NCRWQCB staff review the assumptions in the model. At this time SWRCB and NCRWQCB staff expect future model runs will be done by, and in consultation with, Watercourse Engineering. Future water quality model results must be compared to Basin Plan water quality objectives.

Attached Algae

Watercourse Engineering conducted attached algae sampling last year in the Klamath River below Iron Gate Dam, and in the J.C. Boyle Peaking Reach. SWRCB staff understand that additional sampling will be conducted this year. A study plan should be submitted for SWRCB staff's review and approval. This information will be required to understand the difference in periphyton between the peaking reach and the river below Iron Gate Dam. This information may be critical to develop an understanding of the impacts of the peaking operations, and assumptions that will be used in the WOP condition in the water quality model.

Fish Tissue Analysis

The California Department of Fish and Game (CDFG) collected fish in project reservoirs in 2003 for tissue analysis. SWRCB staff recently contacted CDFG staff that are completing the lab analysis. They indicted that results should be available in April or May 2004. This sampling is considered a screening level analysis only. Once SWRCB staff evaluate the results of the sampling, additional sampling or study may be required to understand the impacts of the project.

Ceratomyxa shasta

The study for *Ceratomyxa shasta* is not complete. The results of the study are needed to understand the project's impact on the habitat for the host species. The project may alter the presence of algae and fine sediments, which appear to the primary habitat for the host species.

Total Dissolved Gases

SWRCB staff requested that PacifiCorp conduct a total dissolved gases study during spill at Iron Gate Dam. It was our understanding that this study was completed, but the results were not included in the application. Additional information has been provided that indicates total dissolved gases may be a problem during normal operations at Iron Gate Powerhouse, and J.C. Boyle Powerhouse. PacifiCorp must demonstrate that the generators, or other project operations, do not result in the entrainment of gases. A study must be prepared in consultation with SWRCB and NCRWQCB staffs.

Sediment Oxygen Demand
Copies of the Eilers and Raymond report on sediment oxygen demand must be submitted to the SWRCB and NCRWQCB.

Evaluation of Beneficial Uses
PacifiCorp must provide a complete analysis of the impacts of the project on water quality objectives. Once this is complete, it must also evaluate the impacts of the project on the beneficial uses of the Klamath River listed above. After the impacts of the project are determined, PacifiCorp must consider a full range of alternatives, and propose alternatives that avoid or mitigate for the impacts of the project.

Recreation
PacifiCorp is proposing to increase the minimum instream flow release and alter peaking operations at J.C. Boyle. A minimum of 200 cfs plus the J.C. Boyle Bypass Reach accretion will be provided at the USGS gauge downstream of the powerhouse. In addition, peaking operations will not exceed a 1,400 cfs maximum change in a 24- hour period. This change is made to provide flow stability for aquatic resources while continuing to provide a balance of whitewater boating and angling opportunities. Whitewater boating and fishing have different flow requirements, and there is no compromise flow that will provide quality versions of both concurrently (Recreation Resources FTR, Page 2-96). Currently whitewater boating and fishing opportunities are provided at "near optimal" (Exhibit E, page 7-115) levels on most days. This statement should be qualified with data. PacifiCorp states "Altered flow regimes with different timing or reduced variation due to peaking would alter the frequency and quality of these existing opportunities." PacifiCorp must provide hydrographs that show the impact of the change in peaking operations on whitewater boating and angling opportunities. PacifiCorp should fully evaluate the impacts of flow changes on boating and angling opportunities and provide appropriate methods to avoid, minimize, or mitigate for any impacts.

Operations Model
Throughout the relicensing process PacifiCorp has provided limited information on project operations and scheduling. It has indicated it has a proprietary operations/power planning model. An operations model must be prepared for use by the SWRCB for this relicensing. The model cannot be proprietary, must function on one hour or smaller time steps, and incorporate reservoir elevations.

Socioeconomics
The application does not include adequate information on the socioeconomics of the project to fully understand the impacts of the range of alternatives that may be considered. PacifiCorp must provide the economics for a full range of alternatives for the project. PacifiCorp should work with the collaborative and complete an analysis of the socioeconomics for a full range of alternatives. This should include the cost of dam removal and the value of salmon and steelhead in a without project scenario.

Collaborative Process

The SWRCB submitted a letter to the FERC on December 31, 2001, expressing staff's concern with the progress made by PacifiCorp on the relicensing process. PacifiCorp made little progress in this relicensing, until they agreed to enter into a collaborative process. While PacifiCorp has made a significant effort toward forming and working with the collaborative, due to early delays by PacifiCorp, the complexity of the project, and the large number of stakeholders, the process has been delayed.

PacifiCorp is following the "traditional relicensing process" rules for the relicensing of the Project. In response to stakeholder requests PacifiCorp agreed to a collaborative effort to develop study plans, review and interpret results of study plans, and (possibly) craft Protection, Mitigation, and Enhancement (PM&E) measures for the Project. For reasons stated in our letter of June 21, 2002, the SWRCB is not a member of, or party to, the collaborative.

While the SWRCB is not a party to the collaborative, SWRCB staff have attended many meetings and provided guidance to PacifiCorp and members of the collaborative on the information that will be required to complete an application for 401 certification. SWRCB staff have made their best efforts to respond to inquiries regarding information requirements for certification under section 401. In addition to attending meetings, SWRCB staff have provided the following written correspondence to PacifiCorp:

First Stage Consultation Package Comments – March 23, 2001
Second Stage Consultation: Study Plans – August 15, 2001
Relicensing Process and Study Plans – December 21, 2001
Second Revision of Draft Study Plan – January 29, 2002
Second Revision of Draft Study Plan – February 28, 2002
Collaborative Process and California Environmental Quality Act Compliance – June 21, 2002
Study Plans – December 23, 2002
Draft Application – September 18, 2003
Water Quality Analysis – January 30, 2004

As discussed above, there are a number of study plans that are still under discussion. It is important that PacifiCorp continue to work with the collaborative to finalize all of the study plans, and complete all needed studies.

California Environmental Quality Act

Issuance of the section 401 certification by the SWRCB is a discretionary action under CEQA. Cal. Pub. Resources Code § 21000 et. seq. Accordingly, the SWRCB will be required to comply with CEQA before issuing a water quality certification.

Under the CEQA Guidelines, California Code of Regulations, title 14, section 15065(a), the lead agency must prepare an Environmental Impact Report (EIR) if a project has the potential to have

a significant adverse environmental impact. An EIR is required if changes in the project could have significant adverse environmental impacts or if the alternatives or mitigation measures could have significant adverse impacts, including incidental adverse impacts of changes that otherwise will provide an overall environmental benefit. An EIR can be prepared directly by, or under contract to, the lead agency. The CEQA Guidelines (Cal. Code Regs. tit. 14, § 15221) directs that lead agencies should try to prepare a combined EIR-EIS. To our knowledge, FERC has not yet determined if it will prepare an EIS or EA (Finding of No Significant Impact) for the Klamath Project relicensing. If the FERC prepares an EIS, and if the FERC's NEPA document satisfies the CEQA mandates (including an appropriate range of alternatives), SWRCB staff would like to jointly coordinate the preparation of a combined document. The SWRCB will coordinate, however, only if the SWRCB retains the ability to intervene in the relicensing proceeding if it so chooses.

TMDL

SWRCB staff and NCRWQCB staff have been working together to coordinate the 401 certification and Total Maximum Daily Load (TMDL) issues relevant to this project. NCRWQCB staff are involved with this project because the information generated by the relicensing process may be useful in developing TMDLs for the Klamath River. The Klamath River is on the state List of Impaired Waterbodies (CWA section 303(d) list). The Project impact water quality in the river, and is therefore relevant to the TMDL analysis. The SWRCB may not be able to issue a 401 certification for this project until the project's contribution to the 303(d) listing is fully understood.

Conclusion

On September 23, 1959, the FPC issued a decision on the application for amendment of license by the California Oregon Power Company to construct Iron Gate Dam. Prior to the construction of Iron Gate Dam, Copco #2 caused fluctuations in flow between 200 and 3300 cfs on a daily basis. These flow fluctuations were having a significant impact on navigation and fisheries in the river. In issuing the decision, the FPC order stated "Evidence adduced at the hearing by the California Department of Fish and Game was to the effect that the Klamath River contributes a major share of California's sport and commercial salmonid fisheries. King (Chinook) salmon, silver salmon and steelhead are the principal species . . . . The evidence shows that fluctuating water levels such as this have a decidedly detrimental effect on fish and aquatic life." The CDFG also provided testimony that the Iron Gate Development would prevent access by salmon and steelhead trout to about 16 miles of spawning gravel and would also destroy one of the most popular stream fishing areas in the upper Klamath River. Representatives of the California Wildlife Federation and Klamath River Sportsman Association "requested that provisions be made to assure a relatively low temperature of the water." The 11th condition and finding of the FPC was that "The Iron Gate Development is desirable and justified in the public interest for the purpose of improving and developing a waterway for the benefit of commerce and for other beneficial public purposes including recreational purposes."

The outcome of the relicensing may have profound effects on the water quality and fisheries of the Klamath River. Salmon and steelhead populations in the Klamath River have a direct and significant effect on the economy of tribes and coastal fishing communities. The economies of tribes and coastal fishing communities reliant on salmon have declined along with the Klamath River salmon. The project has contributed to the long-term decline of the Klamath River and its fishery. These issues will be driving factors in the relicensing of this project.

We look forward to working with PacifiCorp, agencies, Tribes, and NGO's on the relicensing of this project. If you have any questions, or want to discuss the details of these comments, please contact me by phone at (916) 341-5341 or e-mail at rkanz@waterrights.swrcb.ca.gov.

Sincerely,

Russ J. Kanz
Environmental Specialist

Enclosure

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